Bates & Associates, Inc.
Civil Engineering & Surveying
91 W. Colt Square Dr. Suite 3 / Fayetteville, AR 72703
PH: 479-442-9350 * FAX: 479-521-9350

DRAINAGE REPORT

FOR

CENTER POINT CONTRACTORS SHOP BUILDING

BA NO. 13-143

10316 EAST HWY 72
BENTON COUNTY, ARKANSAS

JUNE 6, 2013

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PROJECT OWNER:

Center Point Contractors
10316 East Hwy 72
Bentonville, AR 72712

PROJECT LOCATION:

This project is located 10316 East Hwy 72. See the attached vicinity map for a more detailed location.

PROJECT DESCRIPTION:

The existing site is approximately 5.5 acres and consists of a cleared dirt storage area and grass. The proposed improvements to the site are to add a shop and a class 7 base parking / storage lot. See the site plan for details.

SITE DRAINAGE:

This project is flows into a tributary of Spanker Creek and thence into Spanker Creek and thence into Little Sugar Creek and thence into the Elk River. The soil types for the drainage basin found on the Benton County Arkansas Soil Survey consist of the following: Tonti Gravelly Silt Loam (C), Captina Silt Loam (C).

Group C soils have low infiltration rates when thoroughly wetted and consist chiefly of soils with a layer that impedes downward movement of water and soils with moderately fine to fine texture. These soils have a low rate of water transmission (0.05-0.15 in/hr).

No portion of this property is located in flood zone "A" or is inside the 100-year flood plain as shown by the National Flood Insurance Program's Flood Insurance Rate Map for Benton County, Arkansas (Map No. 05007C0095 K, June 5, 2012).

Currently, the runoff flows from the east to the west and will continue to do so after development.

AREA DRAIANGE PROBLEMS:

We are not aware of any known area drainage problems on or around this property.

DRAINAGE DESIGN:

A runoff curve number for the onsite drainage area was computed for each basin, based on the soil classification, ground cover, and the development in the area. The curve numbers were selected from the City of Bentonville Drainage Manual for pre-development and post-development conditions. See the drainage area map for locations and below for composite curve number calculations.

Pre Developed		Total Acres 5.51
Pasture, grassland good condition	(74)	3.06 ac
Woods in fair condition	(70)	1.18 ac
Dirt	(87)	1.27 ac
Impervious areas	(98)	0.00 ac
Pre developed composite curve number		(76)

Post Developed		Total Acres 5.51
Pasture, grassland good condition	(74)	2.80 ac
Woods in fair condition	(70)	1.18 ac
Class 7 Base	(89)	1.28 ac
Impervious areas	(98)	0.25 ac
Post developed composite curve number		(77)

The 2-year through 100-year frequency storm events for pre- and post- development peak flows were calculated using the drainage program Hydraflow Hydrographs (SCS Method).

SUMMARY OF RUNOFF:

Basin 1

The post-developed peak runoff will slightly increase due to the addition of the class 7 base storage area and the building. However, detention is proposed to reduce the peak runoff to pre developed conditions.

Design Storm	Basin 1 Pre-Dev.	Basin 1 Post Developed	Difference
2-yr	5.97	5.86	-0.11
10-yr	11.43	10.36	-1.07
25-yr	14.29	12.65	-1.64
50-yr	17.18	14.88	-2.30
100-yr	19.37	17.60	-1.77

EROSION AND SEDIMENT CONTROL:

See SWPPP and Erosion Control Plan for details.

CONCLUSION:

Improvements to the site will consist of the addition of a class 7 base storage area and shop building. The additions will replace some of the green space with impervious area and but will only slightly increase the peak runoff from the basin. However, detention is proposed to reduce the peak runoff to pre developed conditions.

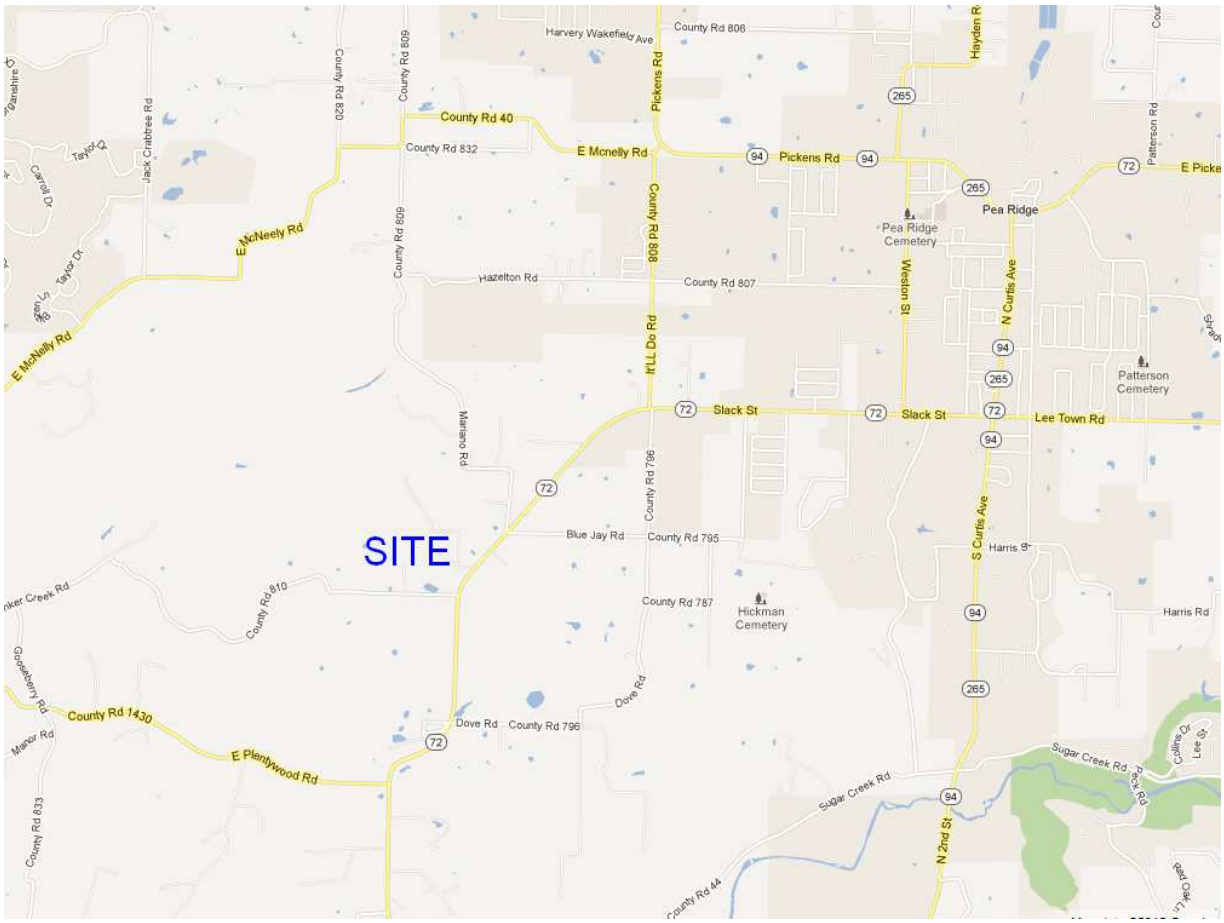
CERTIFICATION:

I, Geoffrey H. Bates, Registered Professional Engineer No. 9810 in the State of Arkansas, hereby certify that the drainage studies, reports, calculations, designs, and specifications contained in this report have been prepared in accordance with the requirements of Benton County. Further, I hereby acknowledge that the review of the drainage studies, reports, calculations, designs, and specifications by Benton County or its representatives cannot and does not relieve me from any professional responsibility or liability."

Sincerely,

Geoffrey Bates

Geoffrey H. Bates, P.E.

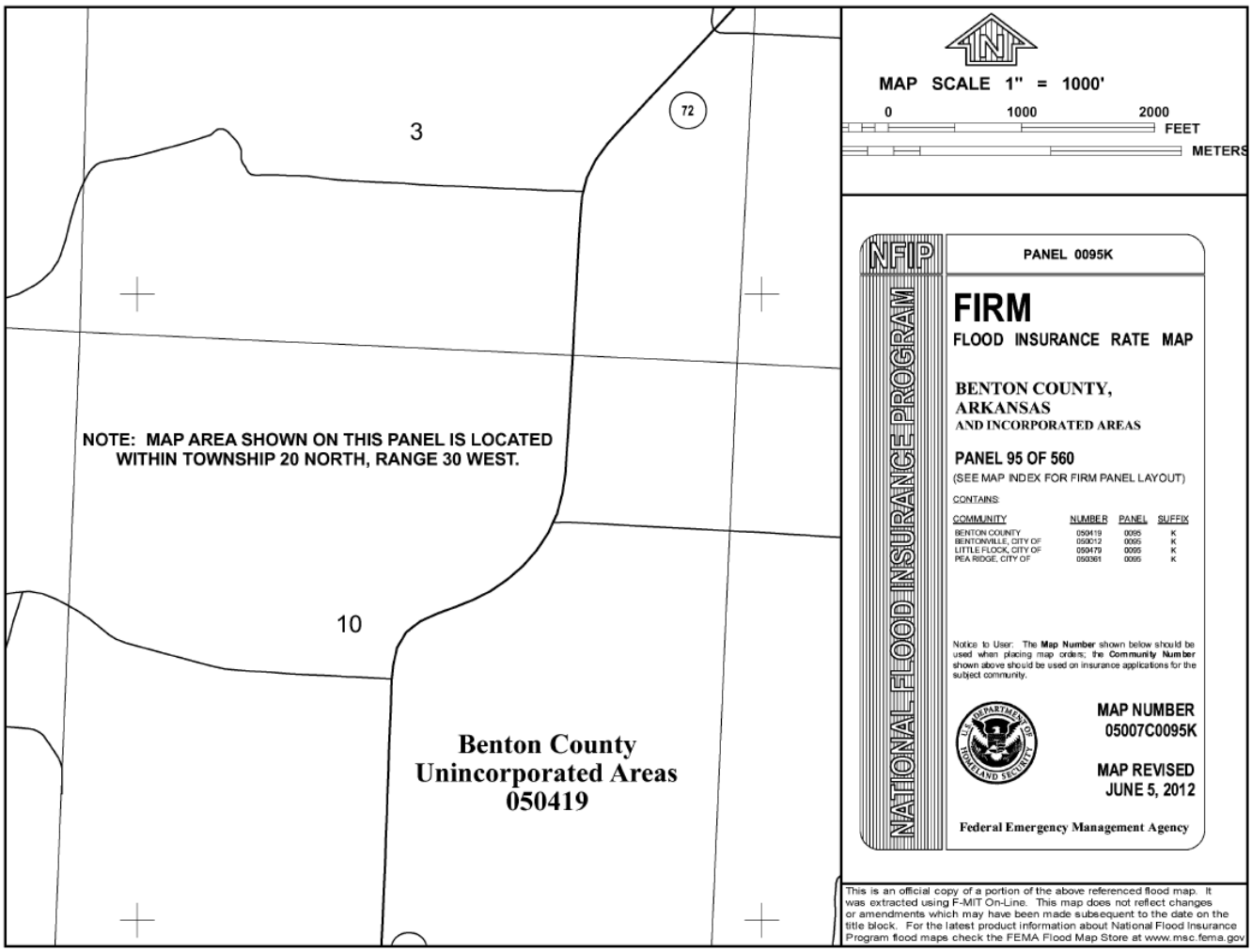


VICINITY MAP

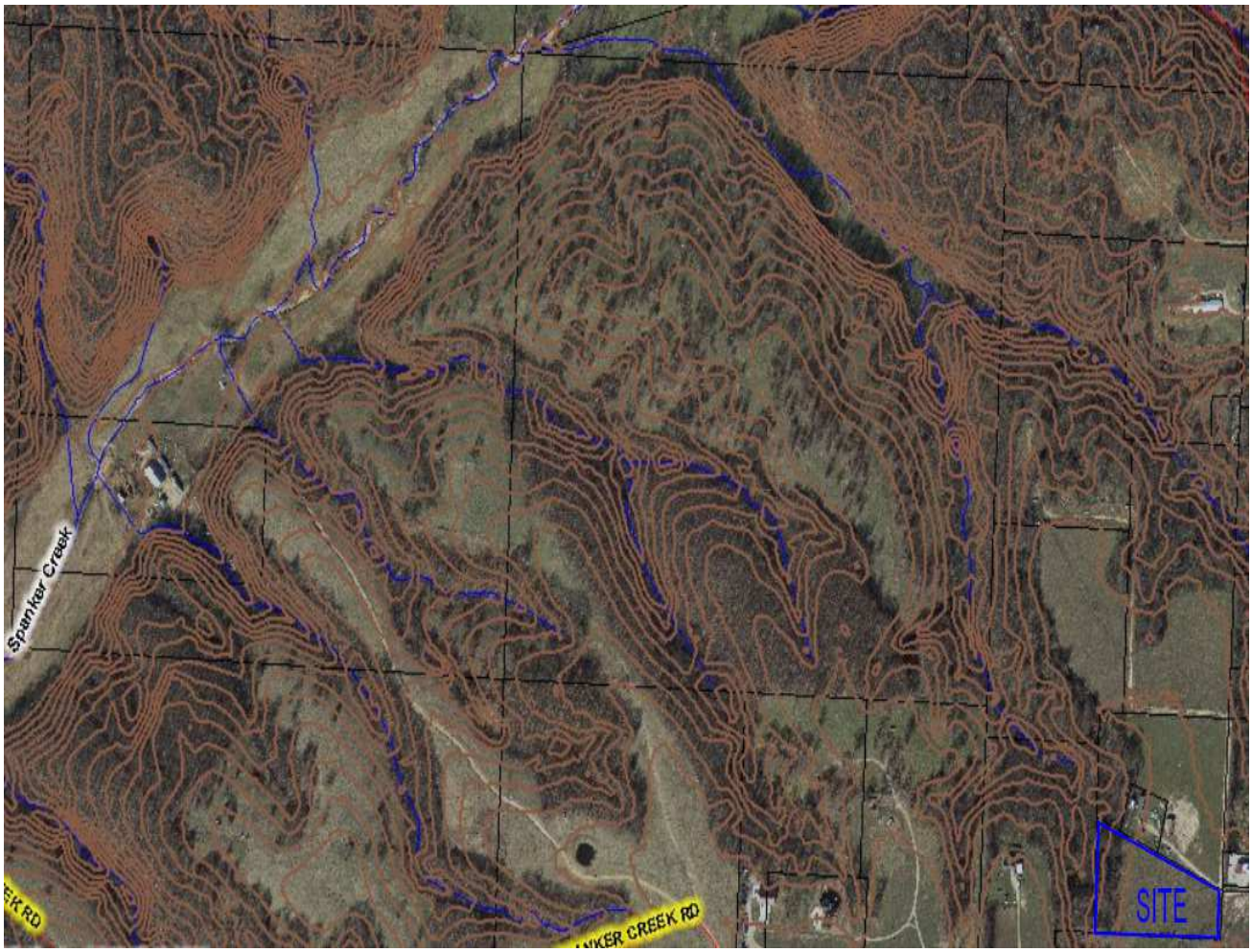
AERIAL PHOTOGRAPH

oam, 20 to 45 percent slopes
Captina silt loam, 1 to 3 percent slopes
SITE
Tonti gravelly silt loam, 3 to 8 percent slopes
E HWY 72
72

SOILS MAP

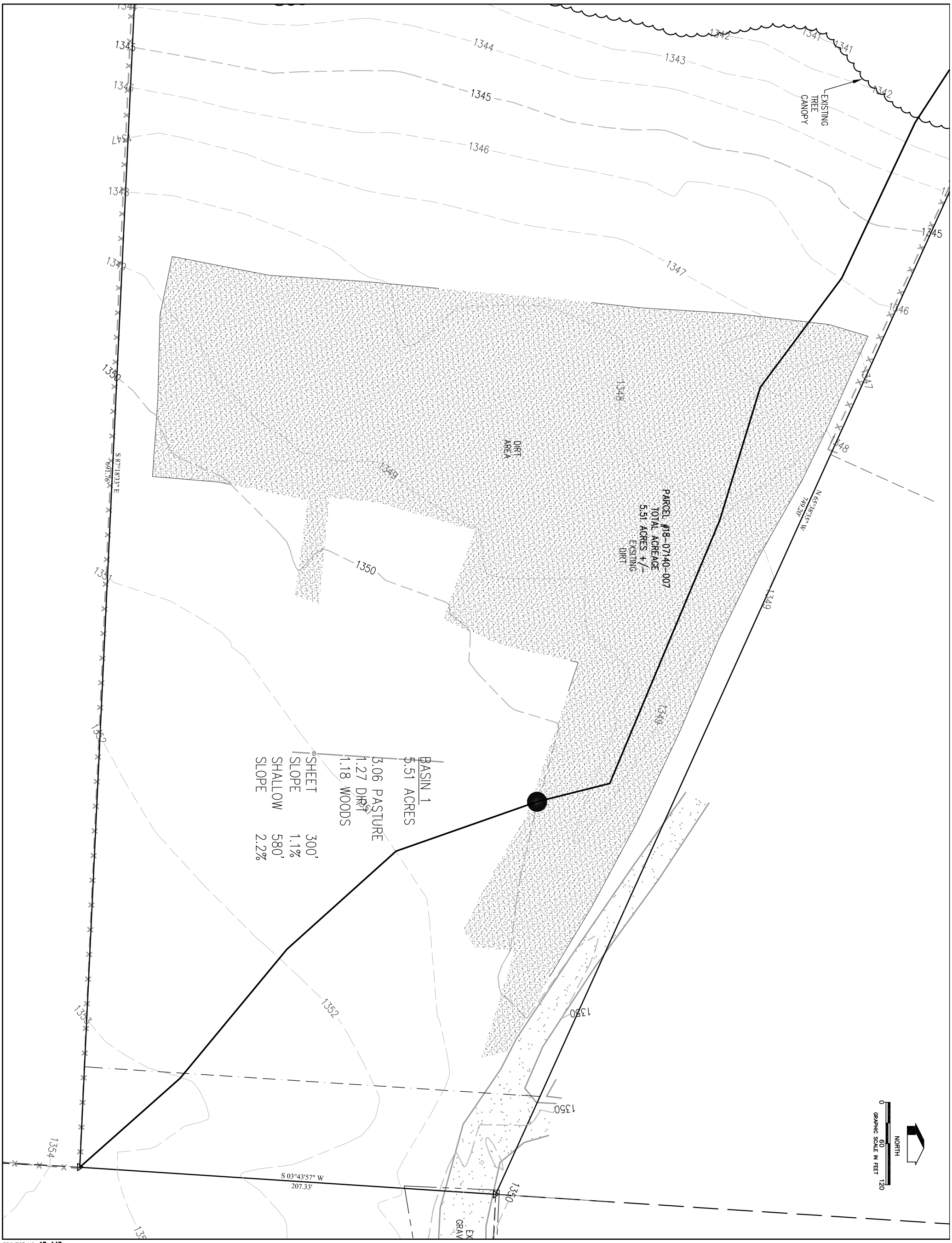


FEMA FIRM PANEL



AREA DRAINAGE MAP

PRE & POST DEVELOPED RUNOFF CALCULATIONS



PROJECT NO **13-143**

DRAWING NO
01

Bates & Associates, Inc.
www.nwabatesinc.com Civil Engineering & Surveying
91 W. Colt Square Dr. · Fayetteville, Arkansas 72703 · 479.442.9350 · Fax 479.521.9350

CENTER POINT CONTRACTORS
PEA RIDGE OFFICE BUILDING
PRE DEVELOPED DRAINAGE MAP

BENTONVILLE, ARKANSAS

REVISIONS	DATE

DRAWN BY: J. Young, E. Niehues ENGINEER:

CERTIFICATE OF AUTHORIZATION BATES & ASSOCIATES, INC. #335 WWW.ARKANSAS.GOV/ENGINEER

STATE OF ARKANSAS REGISTERED PROFESSIONAL ENGINEER GEOFFREY H. BATES No. 9810

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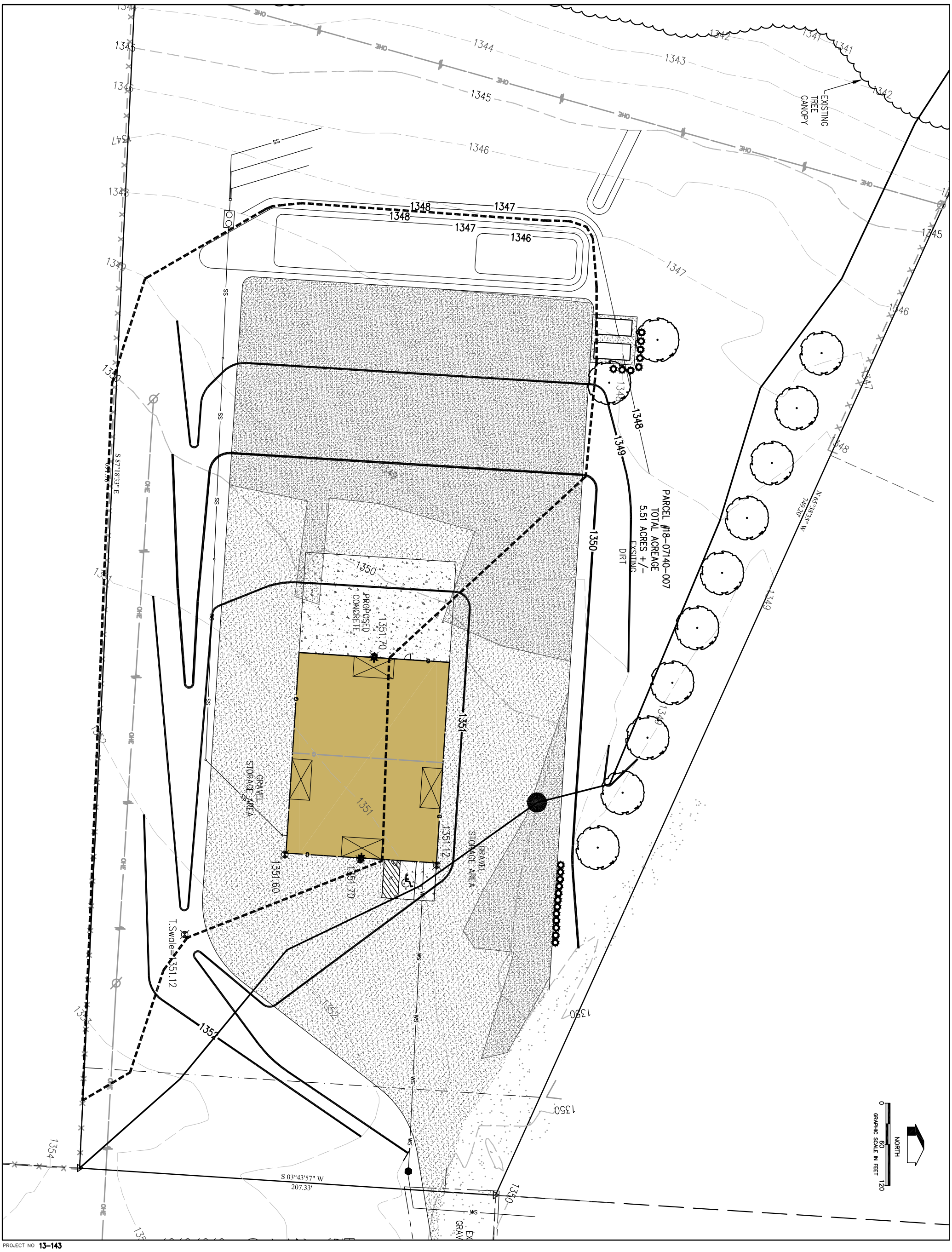

PROJECT NO 13-143

DRAWING NO 02

Bates & Associates, Inc.
www.nwabatesinc.com
Civil Engineering & Surveying
91 W. Colt Square Dr. · Fayetteville, Arkansas 72703 · 479.442.9350 · Fax 479.521.9350

CENTER POINT CONTRACTORS
PEA RIDGE OFFICE BUILDING
POST DEVELOPED DRAINAGE MAP

BENTONVILLE, ARKANSAS

REVISIONS	DATE

DRAWN BY: J. Young, E. Niehues ENGINEER:

CERTIFICATE OF AUTHORIZATION BATES & ASSOCIATES, INC. #135

STATE OF ARKANSAS REGISTERED PROFESSIONAL ENGINEER No. 9810 GEOFFREY H. BATES

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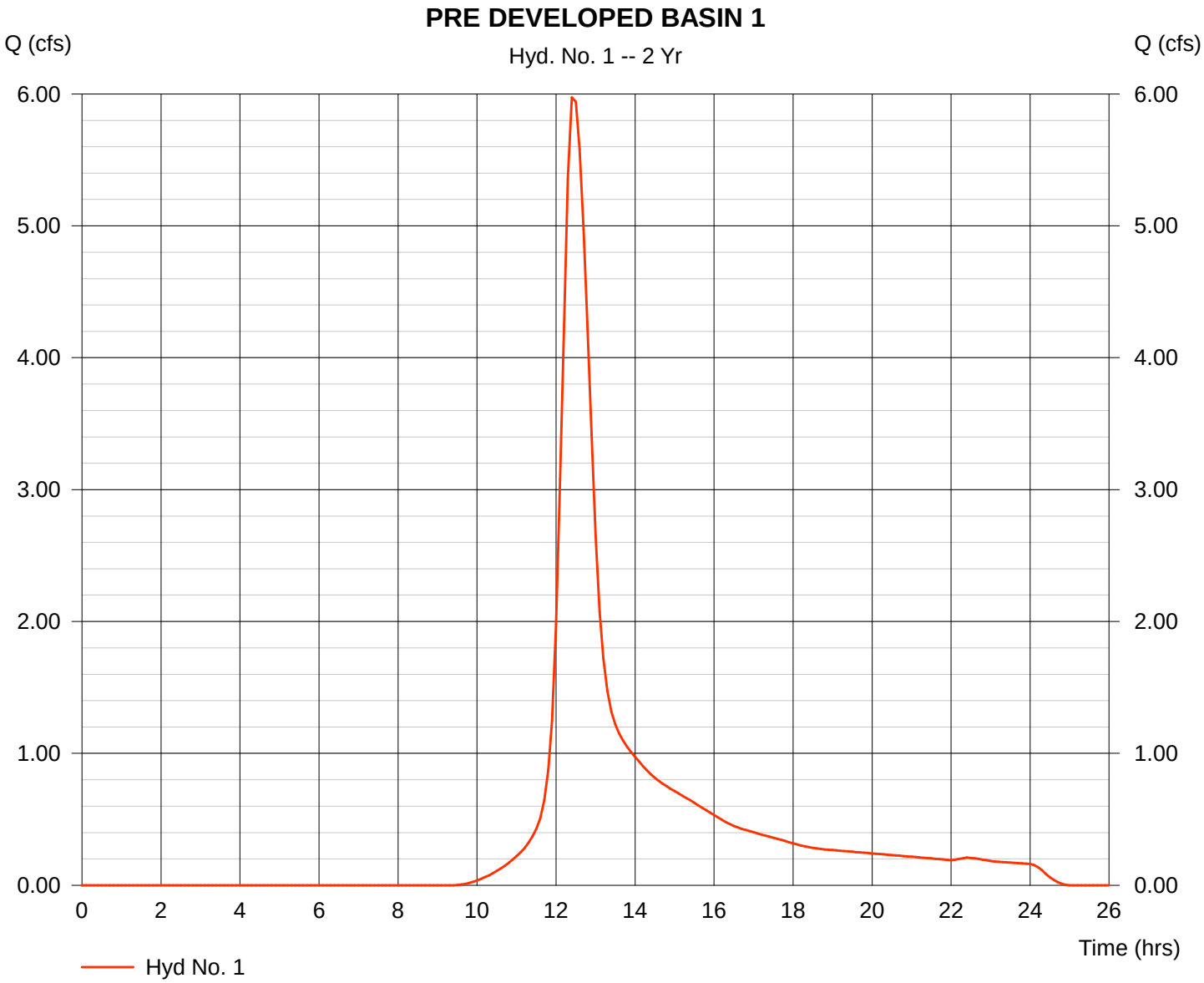
Hydrograph Plot

Hyd. No. 1

PRE DEVELOPED BASIN 1

Hydrograph type	= SCS Runoff	Peak discharge	= 5.97 cfs
Storm frequency	= 2 yrs	Time interval	= 6 min
Drainage area	= 5.510 ac	Curve number	= 76
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 30.60 min
Total precip.	= 4.08 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

Hydrograph Volume = 37,128 cuft



TR55 Tc Worksheet

Hyd. No. 1

PRE DEVELOPED BASIN 1

Description		A		B		C		Totals
Sheet Flow								
Manning's n-value	=	0.150		0.011		0.011		
Flow length (ft)	=	300.0		0.0		0.0		
Two-year 24-hr precip. (in)	=	4.07		0.00		0.00		
Land slope (%)	=	1.10		0.00		0.00		
Travel Time (min)	**=**	**26.57**	**+**	**0.00**	**+**	**0.00**	**=**	**26.57**
Shallow Concentrated Flow								
Flow length (ft)	=	580.00		0.00		0.00		
Watercourse slope (%)	=	2.20		0.00		0.00		
Surface description	=	Unpaved		Paved		Paved		
Average velocity (ft/s)	=	2.39		0.00		0.00		
Travel Time (min)	**=**	**4.04**	**+**	**0.00**	**+**	**0.00**	**=**	**4.04**
Channel Flow								
X sectional flow area (sqft)	=	0.00		0.00		0.00		
Wetted perimeter (ft)	=	0.00		0.00		0.00		
Channel slope (%)	=	0.00		0.00		0.00		
Manning's n-value	=	0.015		0.015		0.015		
Velocity (ft/s)	=	0.00		0.00		0.00		
Flow length (ft)	=	0.0		0.0		0.0		
Travel Time (min)	**=**	**0.00**	**+**	**0.00**	**+**	**0.00**	**=**	**0.00**

Total Travel Time, Tc ..... 30.60 min

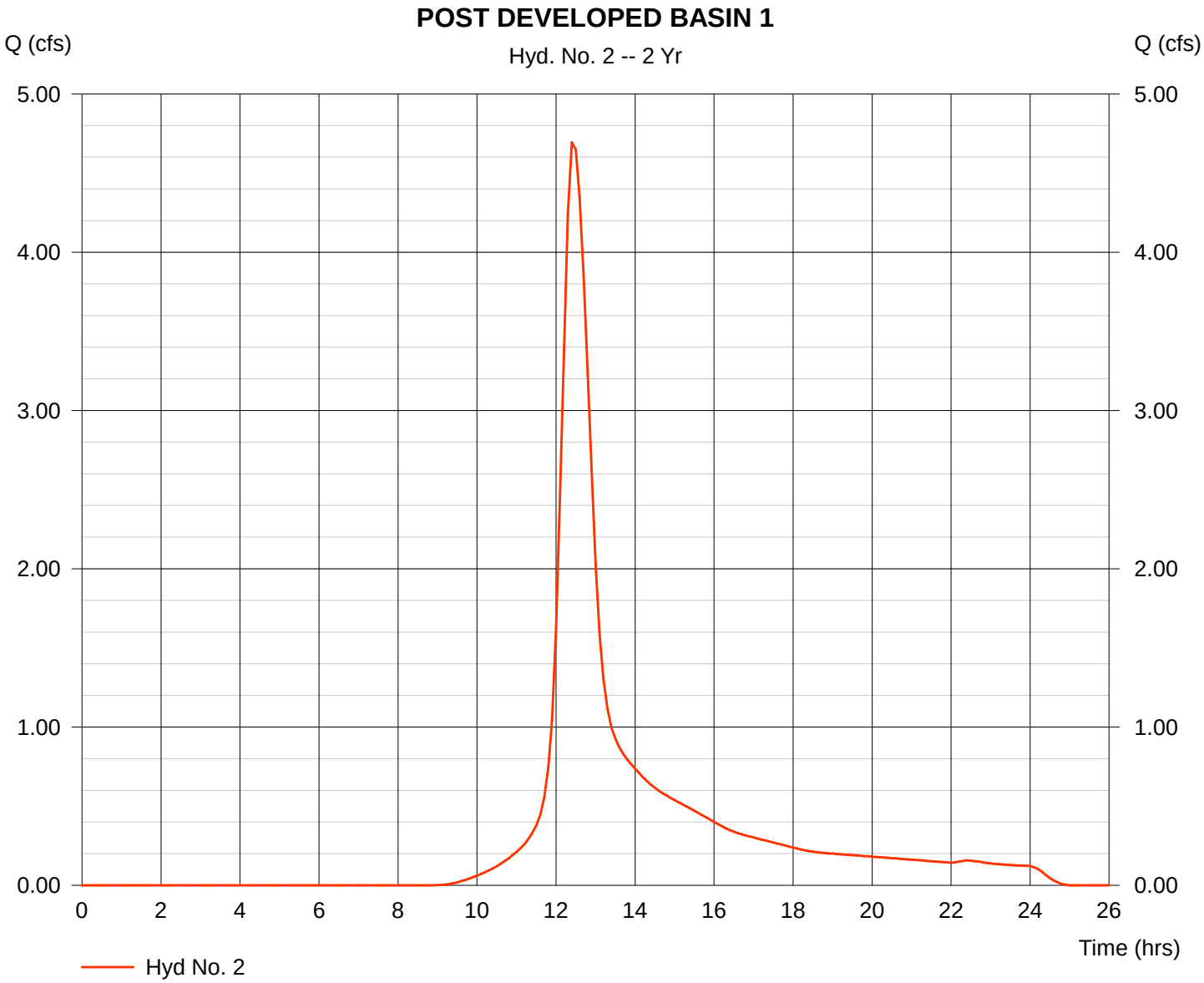
Hydrograph Plot

Hyd. No. 2

POST DEVELOPED BASIN 1

Hydrograph type	= SCS Runoff	Peak discharge	= 4.69 cfs
Storm frequency	= 2 yrs	Time interval	= 6 min
Drainage area	= 3.960 ac	Curve number	= 78
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 30.60 min
Total precip.	= 4.08 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

Hydrograph Volume = 28,920 cuft



TR55 Tc Worksheet

Hyd. No. 2

POST DEVELOPED BASIN 1

Description	A	B	C	Totals
Sheet Flow				
Manning's n-value	= 0.150	0.011	0.011	
Flow length (ft)	= 300.0	0.0	0.0	
Two-year 24-hr precip. (in)	= 4.07	0.00	0.00	
Land slope (%)	= 1.10	0.00	0.00	
Travel Time (min)	**= 26.57 +**	**0.00 +**	**0.00 =**	**26.57**
Shallow Concentrated Flow				
Flow length (ft)	= 580.00	0.00	0.00	
Watercourse slope (%)	= 2.20	0.00	0.00	
Surface description	= Unpaved	Paved	Paved	
Average velocity (ft/s)	= 2.39	0.00	0.00	
Travel Time (min)	**= 4.04 +**	**0.00 +**	**0.00 =**	**4.04**
Channel Flow				
X sectional flow area (sqft)	= 0.00	0.00	0.00	
Wetted perimeter (ft)	= 0.00	0.00	0.00	
Channel slope (%)	= 0.00	0.00	0.00	
Manning's n-value	= 0.015	0.015	0.015	
Velocity (ft/s)	= 0.00	0.00	0.00	
Flow length (ft)	= 0.0	0.0	0.0	
Travel Time (min)	**= 0.00 +**	**0.00 +**	**0.00 =**	**0.00**

Total Travel Time, Tc ..... 30.60 min

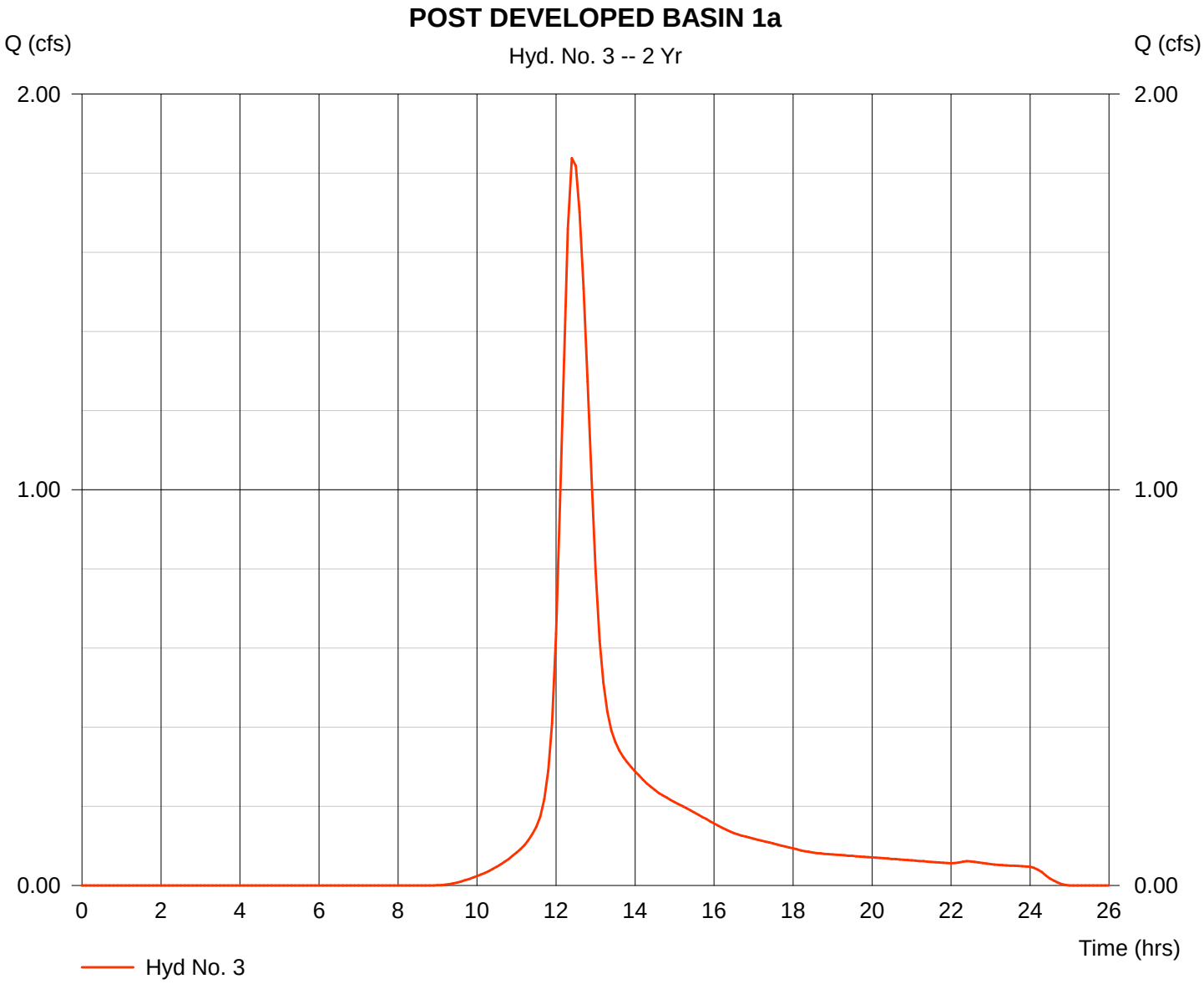
Hydrograph Plot

Hyd. No. 3

POST DEVELOPED BASIN 1a

Hydrograph type	= SCS Runoff	Peak discharge	= 1.84 cfs
Storm frequency	= 2 yrs	Time interval	= 6 min
Drainage area	= 1.550 ac	Curve number	= 78
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 30.60 min
Total precip.	= 4.08 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

Hydrograph Volume = 11,320 cuft



TR55 Tc Worksheet

Hyd. No. 3

POST DEVELOPED BASIN 1a

Description		A		B		C		Totals
Sheet Flow								
Manning's n-value	=	0.150		0.011		0.011		
Flow length (ft)	=	300.0		0.0		0.0		
Two-year 24-hr precip. (in)	=	4.07		0.00		0.00		
Land slope (%)	=	1.10		0.00		0.00		
Travel Time (min)	**=**	**26.57**	**+**	**0.00**	**+**	**0.00**	**=**	**26.57**
Shallow Concentrated Flow								
Flow length (ft)	=	580.00		0.00		0.00		
Watercourse slope (%)	=	2.20		0.00		0.00		
Surface description	=	Unpaved		Paved		Paved		
Average velocity (ft/s)	=	2.39		0.00		0.00		
Travel Time (min)	**=**	**4.04**	**+**	**0.00**	**+**	**0.00**	**=**	**4.04**
Channel Flow								
X sectional flow area (sqft)	=	0.00		0.00		0.00		
Wetted perimeter (ft)	=	0.00		0.00		0.00		
Channel slope (%)	=	0.00		0.00		0.00		
Manning's n-value	=	0.015		0.015		0.015		
Velocity (ft/s)	=	0.00		0.00		0.00		
Flow length (ft)	=	0.0		0.0		0.0		
Travel Time (min)	**=**	**0.00**	**+**	**0.00**	**+**	**0.00**	**=**	**0.00**

Total Travel Time, Tc ..... 30.60 min

Hydrograph Plot

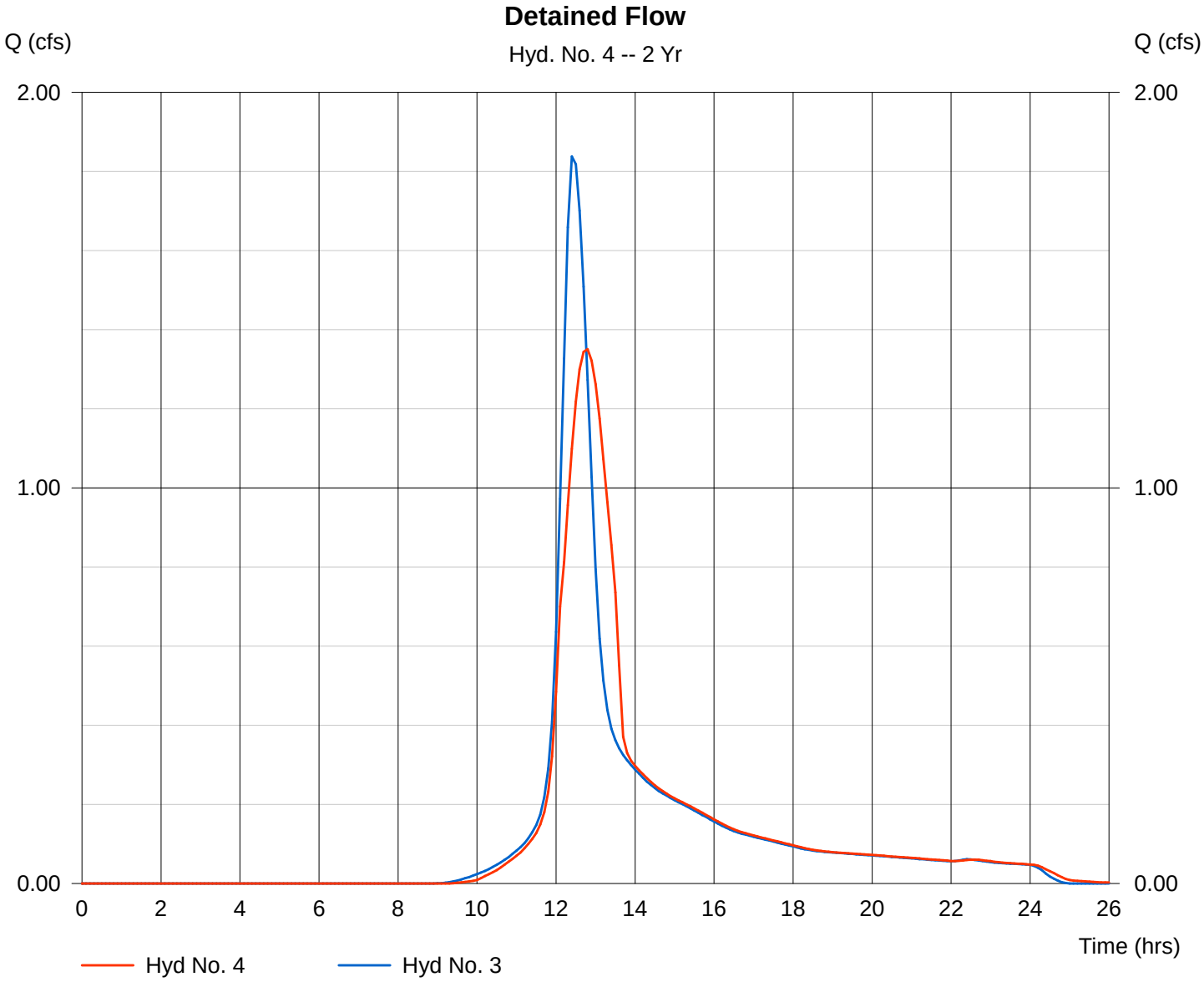
Hydraflow Hydrographs by Intelisolve | Monday, Jun 10 2013, 11:2 AM

Hyd. No. 4

Detained Flow

Hydrograph type	=	Reservoir	Peak discharge	=	1.35 cfs
Storm frequency	=	2 yrs	Time interval	=	6 min
Inflow hyd. No.	=	3	Max. Elevation	=	1346.48 ft
Reservoir name	=	Detention	Max. Storage	=	1,439 cuft

Storage Indication method used. | Hydrograph Volume = 11,317 cuft



Pond Report

Pond No. 1 - Detention

Pond Data

Pond storage is based on known contour areas. Average end area method used.

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	1345.50	10	0	0
0.50	1346.00	992	251	251
1.50	1347.00	3,959	2,476	2,726
2.50	1348.00	5,740	4,850	7,576

Culvert / Orifice Structures

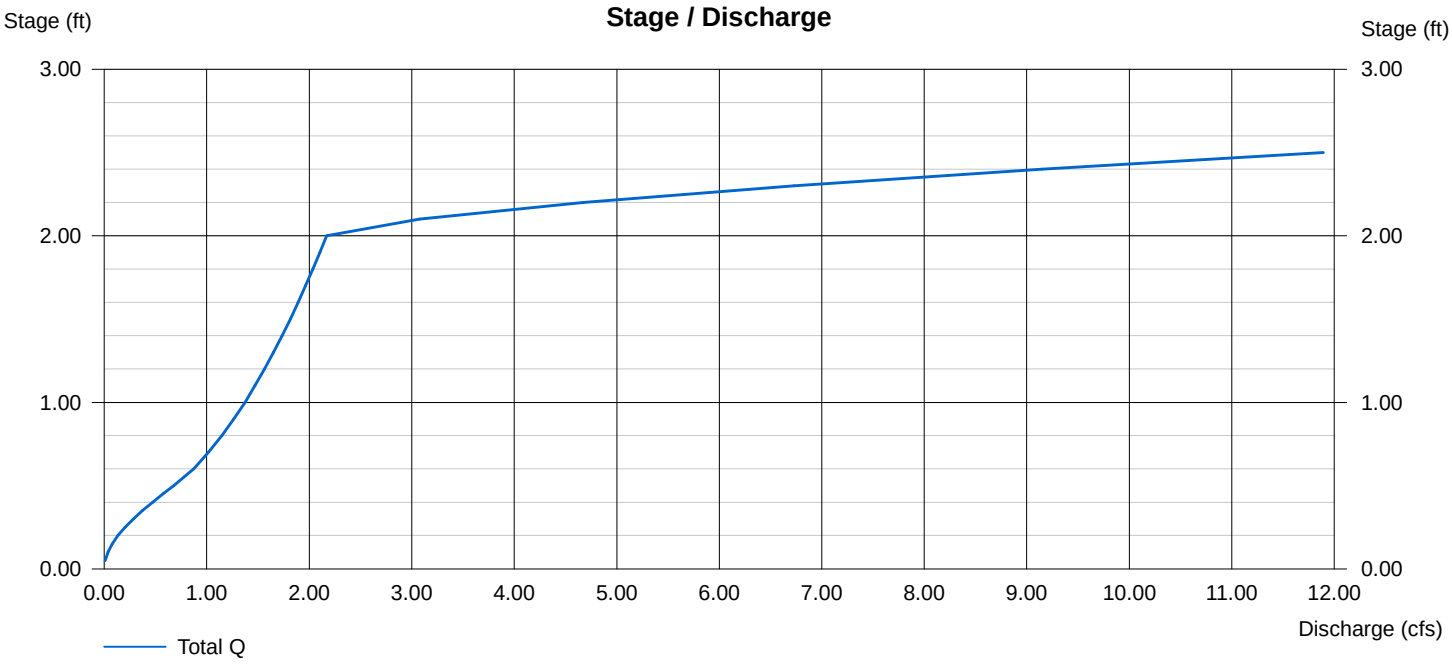
	[A]	[B]	[C]	[D]
Rise (in)	= 8.00	0.00	0.00	0.00
Span (in)	= 8.00	0.00	0.00	0.00
No. Barrels	= 1	0	0	0
Invert El. (ft)	= 1345.50	0.00	0.00	0.00
Length (ft)	= 20.00	0.00	0.00	0.00
Slope (%)	= 2.50	0.00	0.00	0.00
N-Value	= .013	.000	.000	.000
Orif. Coeff.	= 0.60	0.00	0.00	0.00
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 8.00	0.00	0.00	0.00
Crest El. (ft)	= 1347.50	0.00	0.00	0.00
Weir Coeff.	= 3.33	0.00	0.00	0.00
Weir Type	= Ciplti	---	---	---
Multi-Stage	= No	No	No	No

Exfiltration = 0.000 in/hr (Contour) Tailwater Elev. = 0.00 ft

Note: Culvert/Orifice outflows have been analyzed under inlet and outlet control.



Hydrograph Plot

Hydraflow Hydrographs by Intelisolve

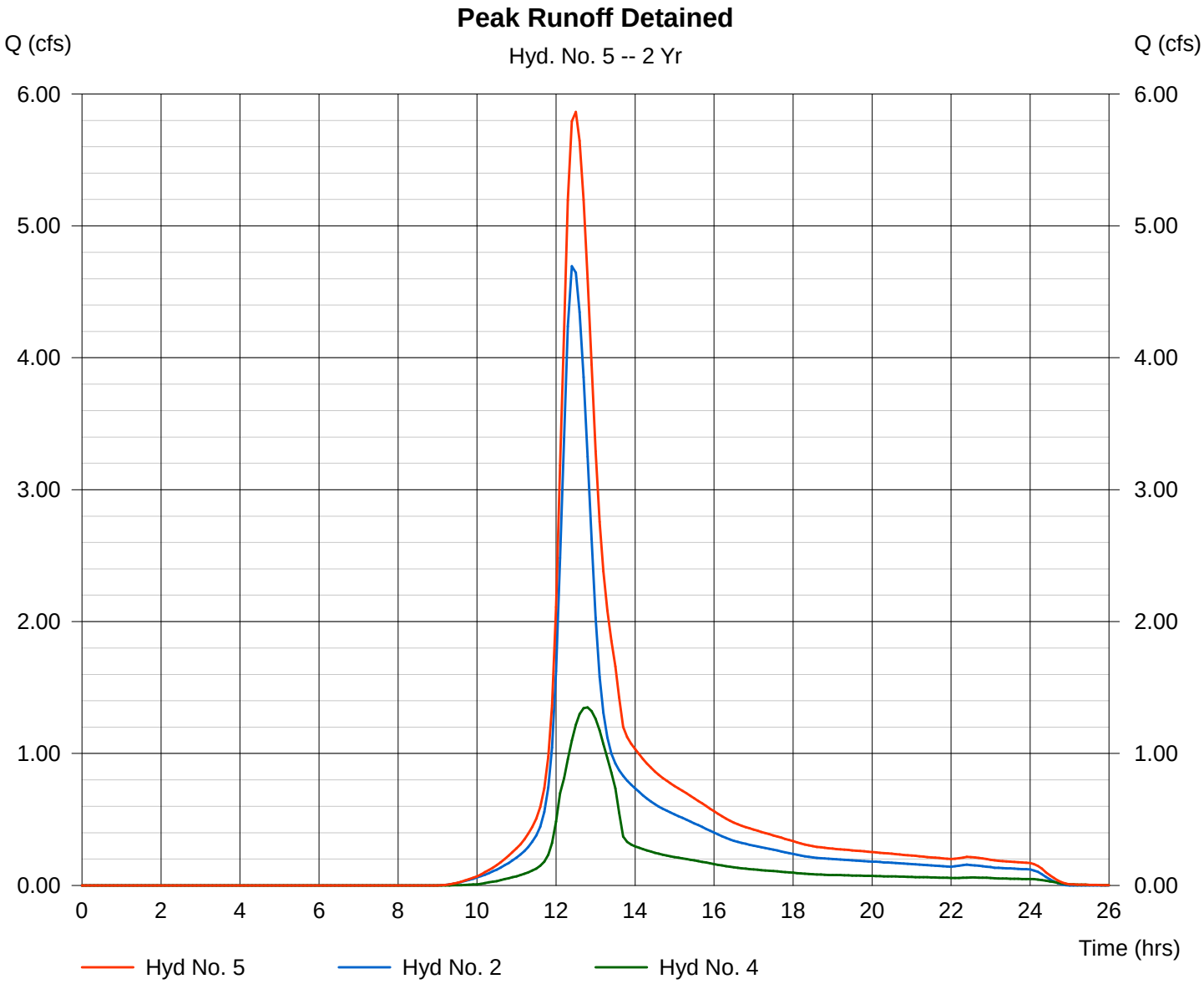
Monday, Jun 10 2013, 11:2 AM

Hyd. No. 5

Peak Runoff Detained

Hydrograph type	= Combine	Peak discharge	= 5.86 cfs
Storm frequency	= 2 yrs	Time interval	= 6 min
Inflow hyds.	= 2, 4		

Hydrograph Volume = 40,237 cuft



Hydrograph Return Period Recap

Hyd. No.	Hydrograph type (origin)	Inflow Hyd(s)	Peak Outflow (cfs)								Hydrograph description
			1-Yr	2-Yr	3-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr	
1	SCS Runoff	-------	-------	5.97	-------	-------	11.43	14.29	17.18	19.37	PRE DEVELOPED BASIN 1
2	SCS Runoff	-------	-------	4.69	-------	-------	8.71	10.78	12.88	14.45	POST DEVELOPED BASIN 1
3	SCS Runoff	-------	-------	1.84	-------	-------	3.41	4.22	5.04	5.66	POST DEVELOPED BASIN 1a
4	Reservoir	3	-------	1.35	-------	-------	1.99	2.48	3.97	4.76	Detained Flow
5	Combine	2, 4	-------	5.86	-------	-------	10.36	12.65	14.88	17.60	Peak Runoff Detained

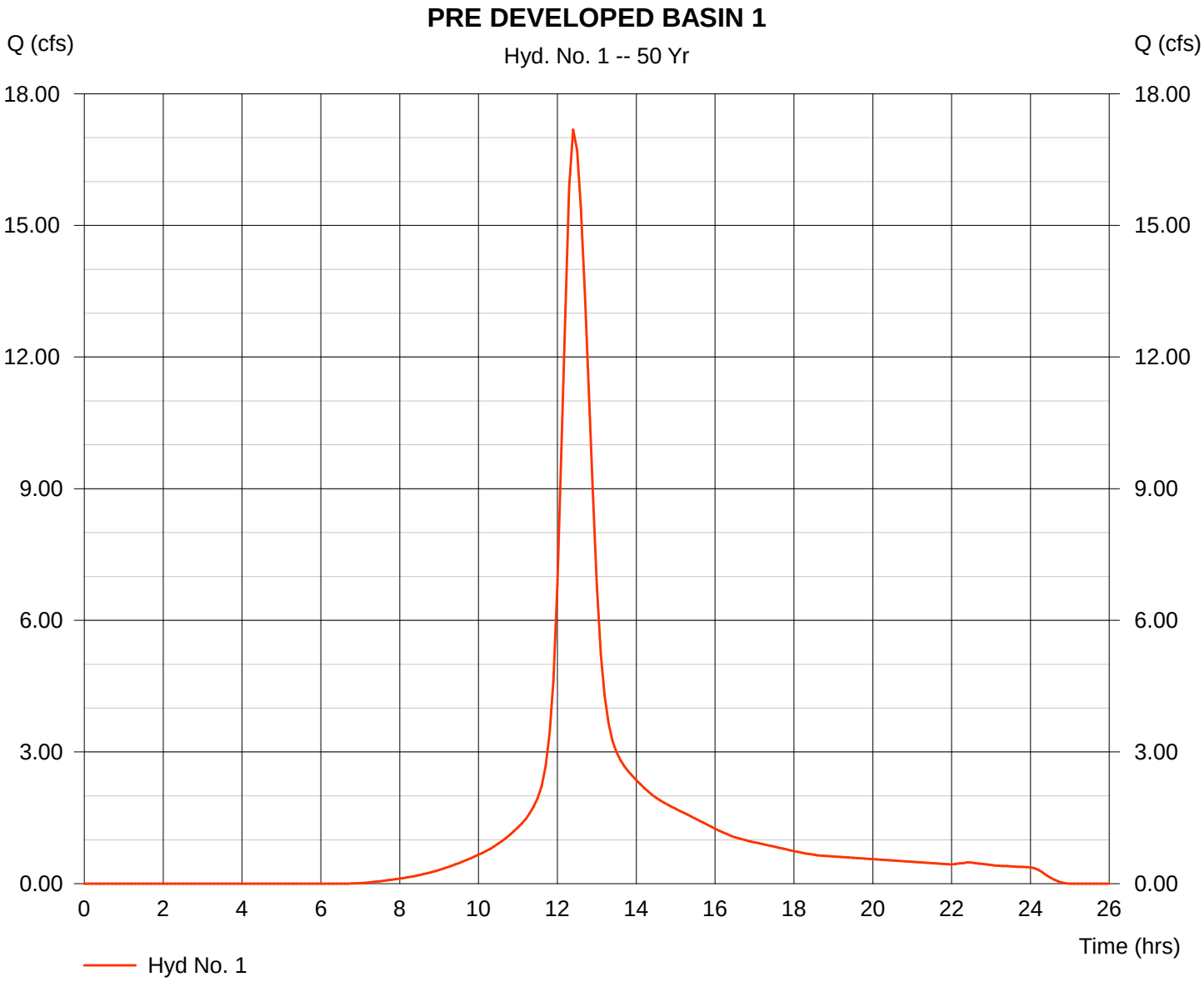
Hydrograph Plot

Hyd. No. 1

PRE DEVELOPED BASIN 1

Hydrograph type	= SCS Runoff	Peak discharge	= 17.18 cfs
Storm frequency	= 50 yrs	Time interval	= 6 min
Drainage area	= 5.510 ac	Curve number	= 76
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 30.60 min
Total precip.	= 7.92 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

Hydrograph Volume = 104,888 cuft



TR55 Tc Worksheet

Hyd. No. 1

PRE DEVELOPED BASIN 1

Description		A		B		C		Totals
Sheet Flow								
Manning's n-value	=	0.150		0.011		0.011		
Flow length (ft)	=	300.0		0.0		0.0		
Two-year 24-hr precip. (in)	=	4.07		0.00		0.00		
Land slope (%)	=	1.10		0.00		0.00		
Travel Time (min)	**=**	**26.57**	**+**	**0.00**	**+**	**0.00**	**=**	**26.57**
Shallow Concentrated Flow								
Flow length (ft)	=	580.00		0.00		0.00		
Watercourse slope (%)	=	2.20		0.00		0.00		
Surface description	=	Unpaved		Paved		Paved		
Average velocity (ft/s)	=	2.39		0.00		0.00		
Travel Time (min)	**=**	**4.04**	**+**	**0.00**	**+**	**0.00**	**=**	**4.04**
Channel Flow								
X sectional flow area (sqft)	=	0.00		0.00		0.00		
Wetted perimeter (ft)	=	0.00		0.00		0.00		
Channel slope (%)	=	0.00		0.00		0.00		
Manning's n-value	=	0.015		0.015		0.015		
Velocity (ft/s)	=	0.00		0.00		0.00		
Flow length (ft)	=	0.0		0.0		0.0		
Travel Time (min)	**=**	**0.00**	**+**	**0.00**	**+**	**0.00**	**=**	**0.00**

Total Travel Time, Tc ..... 30.60 min

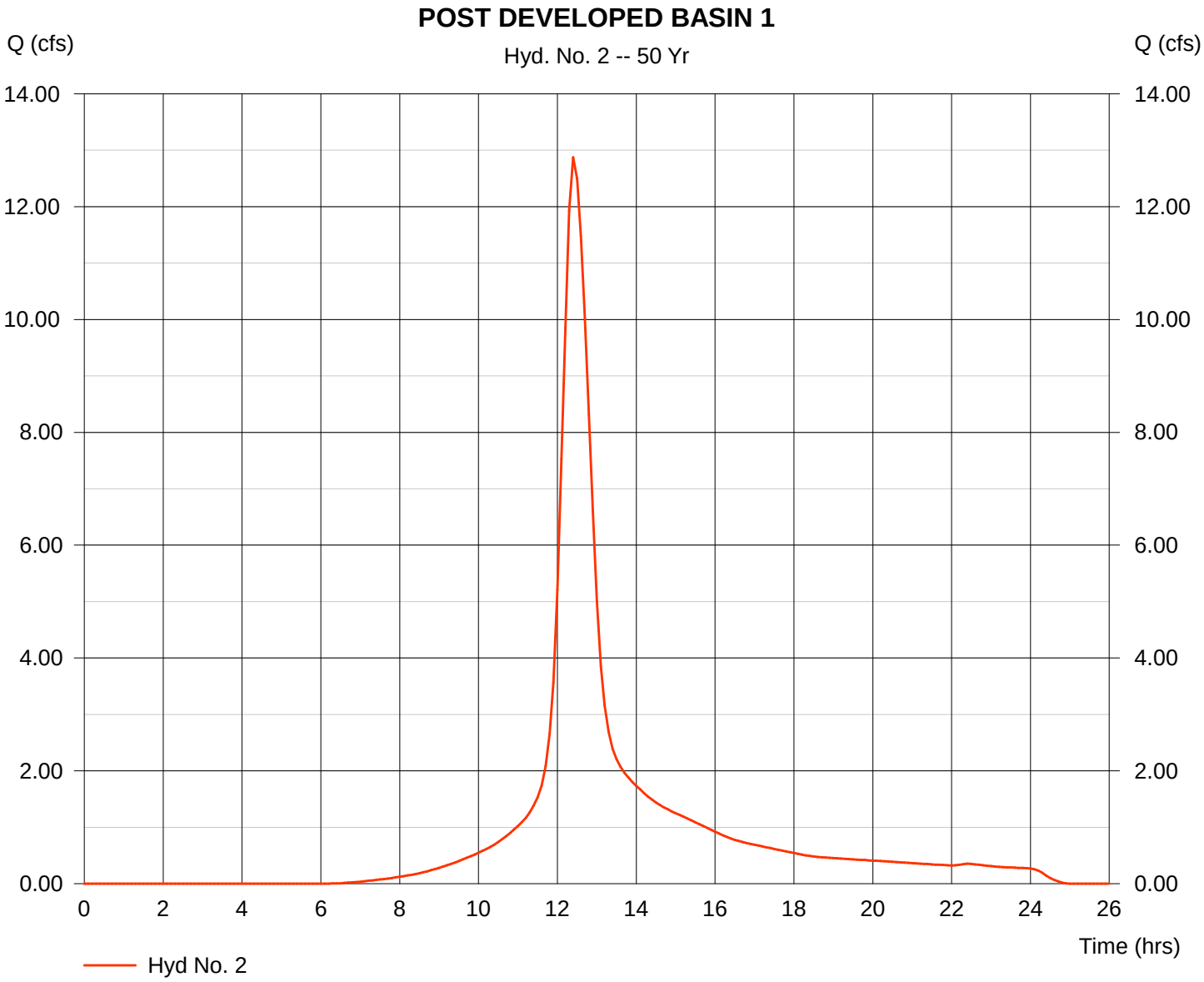
Hydrograph Plot

Hyd. No. 2

POST DEVELOPED BASIN 1

Hydrograph type	= SCS Runoff	Peak discharge	= 12.88 cfs
Storm frequency	= 50 yrs	Time interval	= 6 min
Drainage area	= 3.960 ac	Curve number	= 78
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 30.60 min
Total precip.	= 7.92 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

Hydrograph Volume = 78,821 cuft



TR55 Tc Worksheet

Hyd. No. 2

POST DEVELOPED BASIN 1

Description	A	B	C	Totals
Sheet Flow				
Manning's n-value	= 0.150	0.011	0.011	
Flow length (ft)	= 300.0	0.0	0.0	
Two-year 24-hr precip. (in)	= 4.07	0.00	0.00	
Land slope (%)	= 1.10	0.00	0.00	
Travel Time (min)	**= 26.57 +**	**0.00 +**	**0.00 =**	**26.57**
Shallow Concentrated Flow				
Flow length (ft)	= 580.00	0.00	0.00	
Watercourse slope (%)	= 2.20	0.00	0.00	
Surface description	= Unpaved	Paved	Paved	
Average velocity (ft/s)	= 2.39	0.00	0.00	
Travel Time (min)	**= 4.04 +**	**0.00 +**	**0.00 =**	**4.04**
Channel Flow				
X sectional flow area (sqft)	= 0.00	0.00	0.00	
Wetted perimeter (ft)	= 0.00	0.00	0.00	
Channel slope (%)	= 0.00	0.00	0.00	
Manning's n-value	= 0.015	0.015	0.015	
Velocity (ft/s)	= 0.00	0.00	0.00	
Flow length (ft)	= 0.0	0.0	0.0	
Travel Time (min)	**= 0.00 +**	**0.00 +**	**0.00 =**	**0.00**

Total Travel Time, Tc ..... 30.60 min

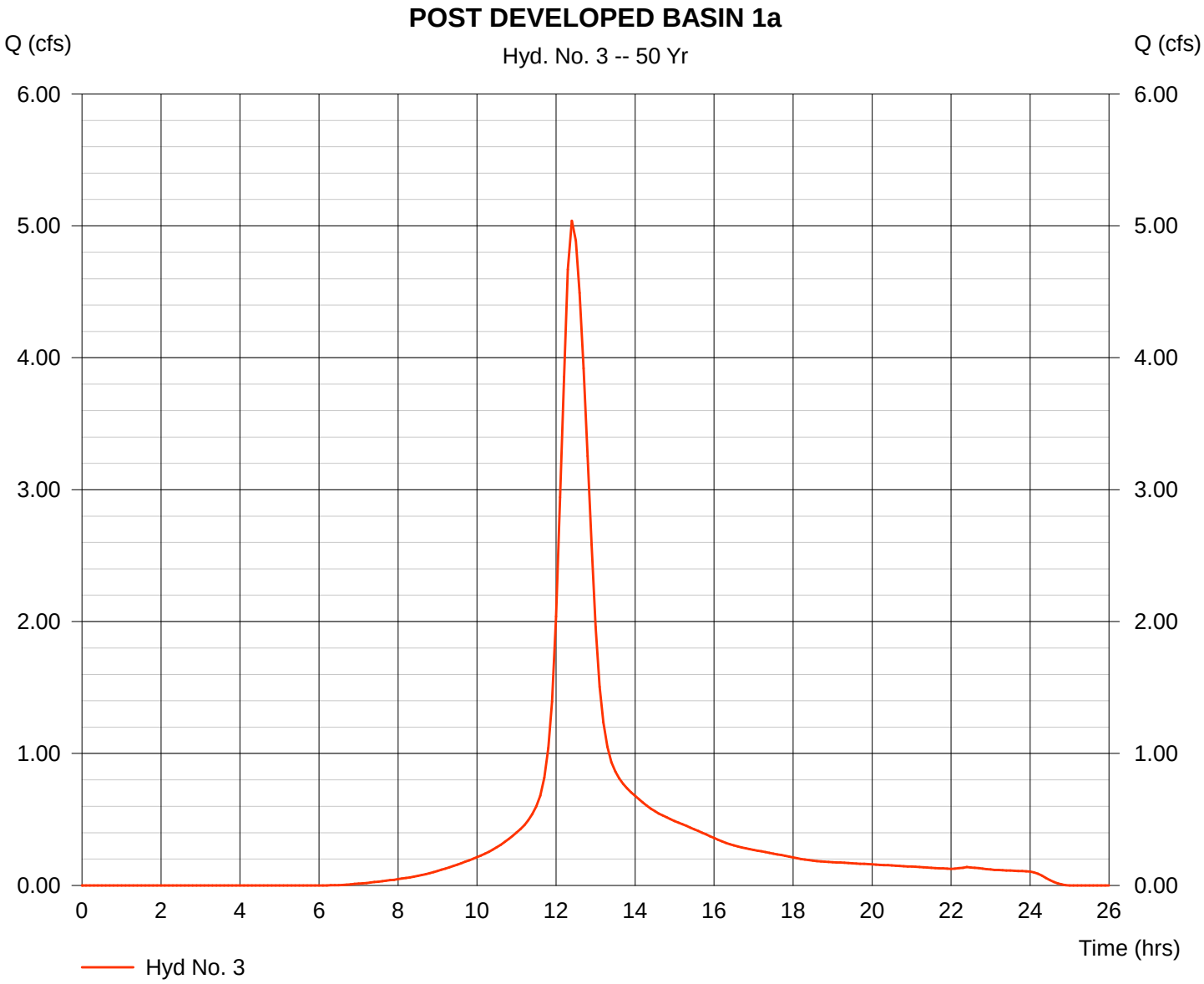
Hydrograph Plot

Hyd. No. 3

POST DEVELOPED BASIN 1a

Hydrograph type	= SCS Runoff	Peak discharge	= 5.04 cfs
Storm frequency	= 50 yrs	Time interval	= 6 min
Drainage area	= 1.550 ac	Curve number	= 78
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 30.60 min
Total precip.	= 7.92 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

Hydrograph Volume = 30,852 cuft



TR55 Tc Worksheet

Hyd. No. 3

POST DEVELOPED BASIN 1a

Description	A	B	C	Totals
Sheet Flow				
Manning's n-value	= 0.150	0.011	0.011	
Flow length (ft)	= 300.0	0.0	0.0	
Two-year 24-hr precip. (in)	= 4.07	0.00	0.00	
Land slope (%)	= 1.10	0.00	0.00	
Travel Time (min)	**= 26.57**	**+ 0.00**	**+ 0.00**	**= 26.57**
Shallow Concentrated Flow				
Flow length (ft)	= 580.00	0.00	0.00	
Watercourse slope (%)	= 2.20	0.00	0.00	
Surface description	= Unpaved	Paved	Paved	
Average velocity (ft/s)	= 2.39	0.00	0.00	
Travel Time (min)	**= 4.04**	**+ 0.00**	**+ 0.00**	**= 4.04**
Channel Flow				
X sectional flow area (sqft)	= 0.00	0.00	0.00	
Wetted perimeter (ft)	= 0.00	0.00	0.00	
Channel slope (%)	= 0.00	0.00	0.00	
Manning's n-value	= 0.015	0.015	0.015	
Velocity (ft/s)	= 0.00	0.00	0.00	
Flow length (ft)	= 0.0	0.0	0.0	
Travel Time (min)	**= 0.00**	**+ 0.00**	**+ 0.00**	**= 0.00**

Total Travel Time, Tc ..... 30.60 min

Hydrograph Plot

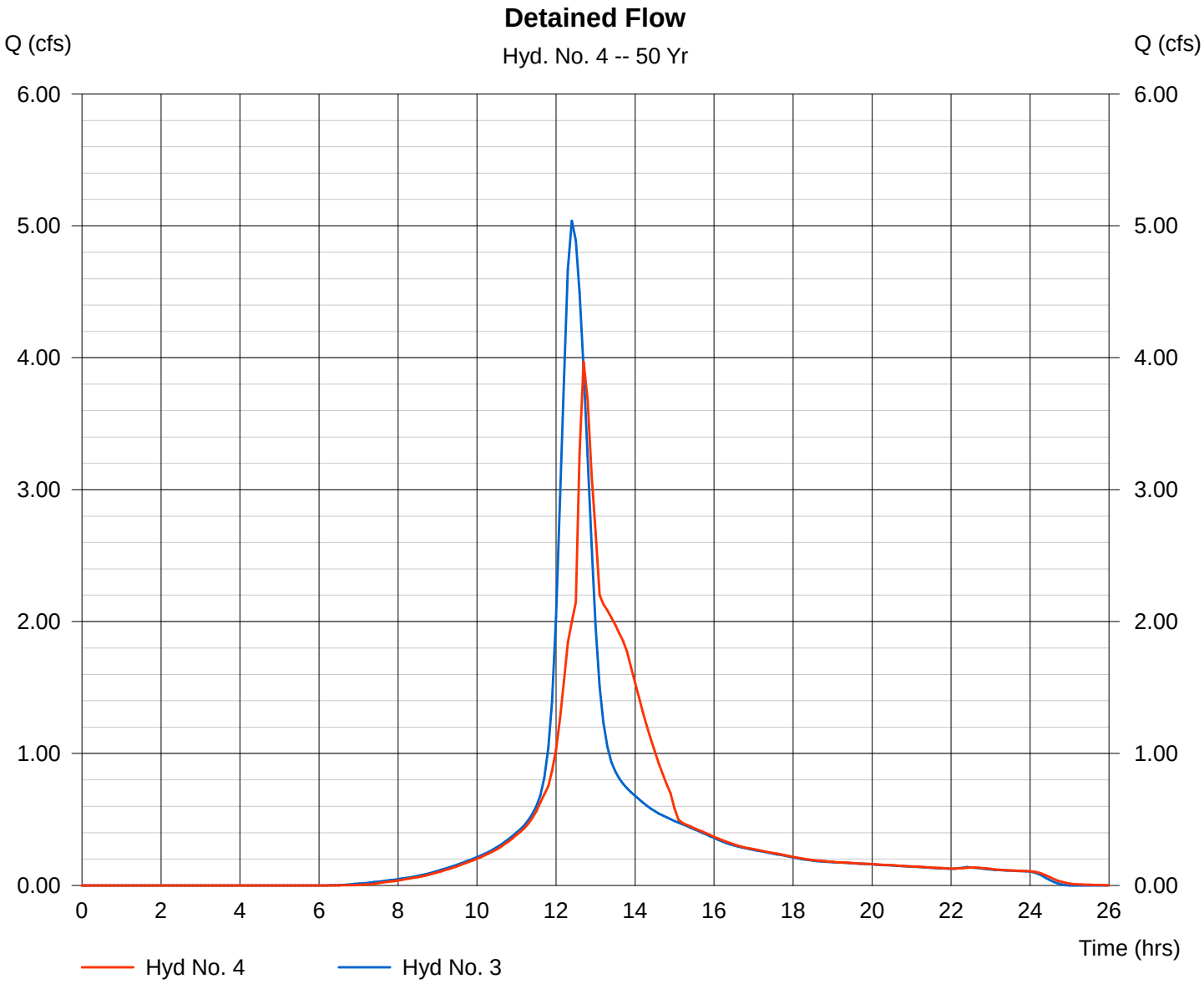
Hydraflow Hydrographs by Intelisolve | Monday, Jun 10 2013, 11:2 AM

Hyd. No. 4

Detained Flow

Hydrograph type	=	Reservoir	Peak discharge	=	3.97 cfs
Storm frequency	=	50 yrs	Time interval	=	6 min
Inflow hyd. No.	=	3	Max. Elevation	=	1347.66 ft
Reservoir name	=	Detention	Max. Storage	=	5,907 cuft

Storage Indication method used. | Hydrograph Volume = 30,849 cuft



Pond Report

Pond No. 1 - Detention

Pond Data

Pond storage is based on known contour areas. Average end area method used.

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	1345.50	10	0	0
0.50	1346.00	992	251	251
1.50	1347.00	3,959	2,476	2,726
2.50	1348.00	5,740	4,850	7,576

Culvert / Orifice Structures

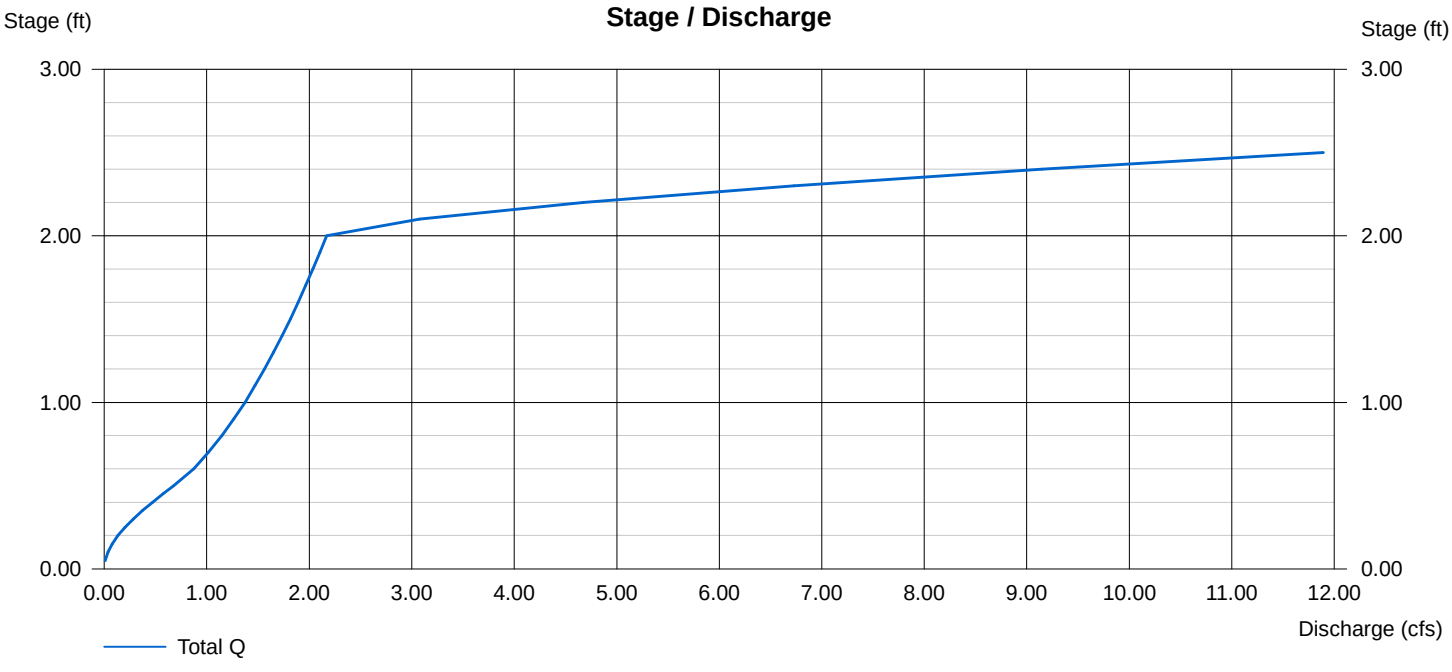
	[A]	[B]	[C]	[D]
Rise (in)	= 8.00	0.00	0.00	0.00
Span (in)	= 8.00	0.00	0.00	0.00
No. Barrels	= 1	0	0	0
Invert El. (ft)	= 1345.50	0.00	0.00	0.00
Length (ft)	= 20.00	0.00	0.00	0.00
Slope (%)	= 2.50	0.00	0.00	0.00
N-Value	= .013	.000	.000	.000
Orif. Coeff.	= 0.60	0.00	0.00	0.00
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 8.00	0.00	0.00	0.00
Crest El. (ft)	= 1347.50	0.00	0.00	0.00
Weir Coeff.	= 3.33	0.00	0.00	0.00
Weir Type	= Ciplti	---	---	---
Multi-Stage	= No	No	No	No

Exfiltration = 0.000 in/hr (Contour) Tailwater Elev. = 0.00 ft

Note: Culvert/Orifice outflows have been analyzed under inlet and outlet control.



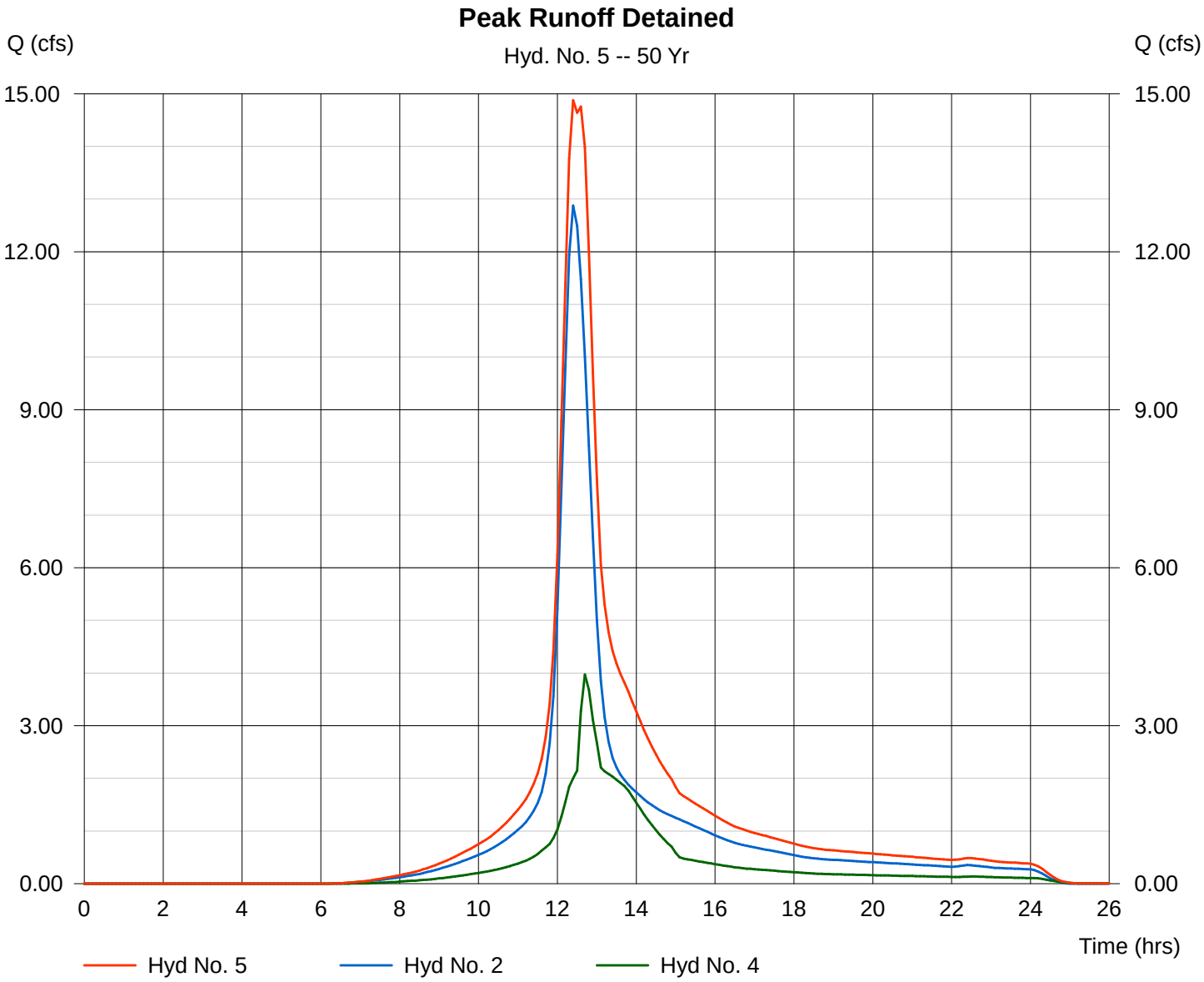
Hydrograph Plot

Hyd. No. 5

Peak Runoff Detained

Hydrograph type	= Combine	Peak discharge	= 14.88 cfs
Storm frequency	= 50 yrs	Time interval	= 6 min
Inflow hyds.	= 2, 4		

Hydrograph Volume = 109,670 cuft



Hydrograph Plot

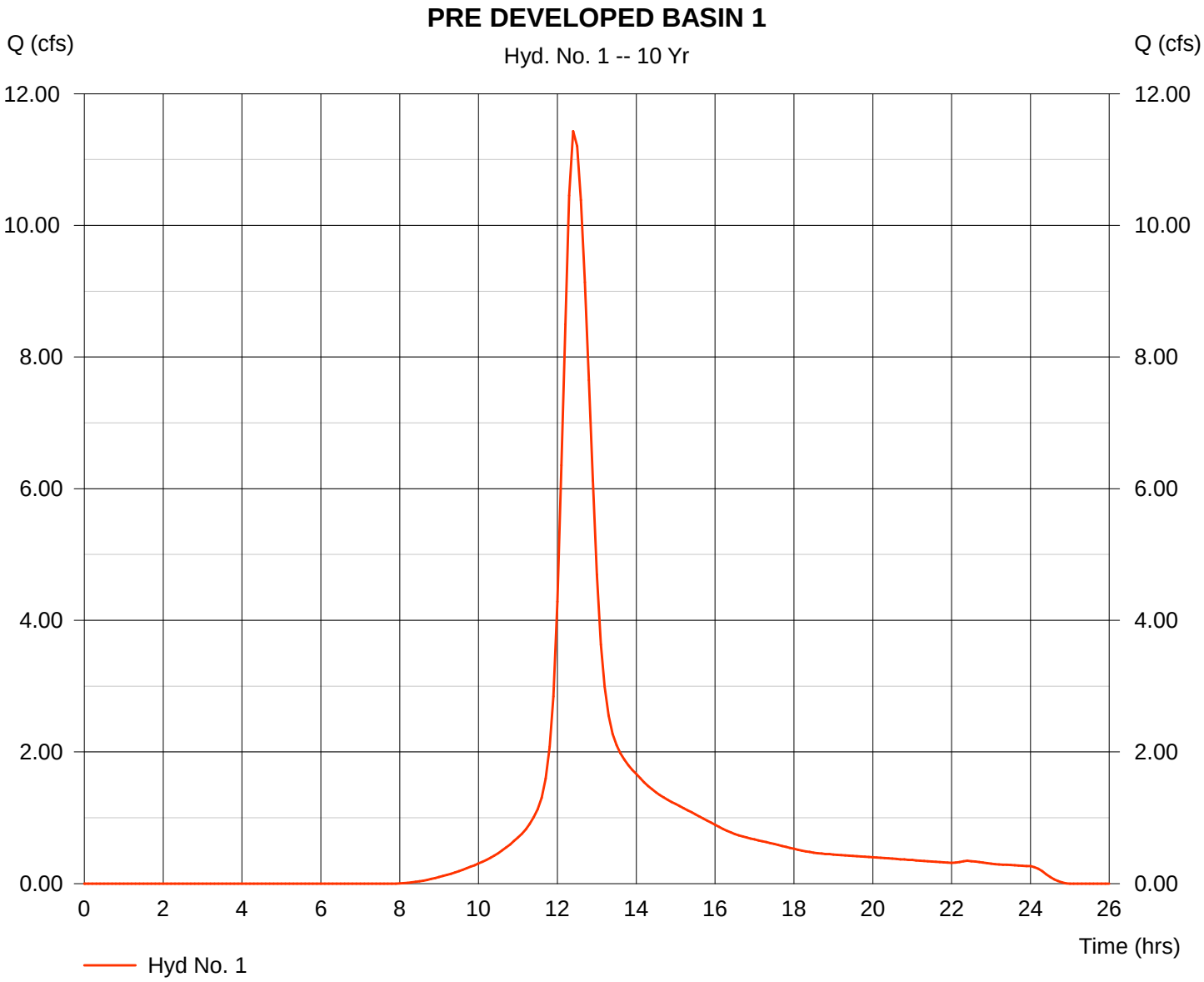
Hydraflow Hydrographs by Intelisolve | Monday, Jun 10 2013, 11:2 AM

Hyd. No. 1

PRE DEVELOPED BASIN 1

Hydrograph type	= SCS Runoff	Peak discharge	= 11.43 cfs
Storm frequency	= 10 yrs	Time interval	= 6 min
Drainage area	= 5.510 ac	Curve number	= 76
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 30.60 min
Total precip.	= 6.00 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

Hydrograph Volume = 69,719 cuft



TR55 Tc Worksheet

Hyd. No. 1

PRE DEVELOPED BASIN 1

Description		A		B		C		Totals
Sheet Flow								
Manning's n-value	=	0.150		0.011		0.011		
Flow length (ft)	=	300.0		0.0		0.0		
Two-year 24-hr precip. (in)	=	4.07		0.00		0.00		
Land slope (%)	=	1.10		0.00		0.00		
Travel Time (min)	**=**	**26.57**	**+**	**0.00**	**+**	**0.00**	**=**	**26.57**
Shallow Concentrated Flow								
Flow length (ft)	=	580.00		0.00		0.00		
Watercourse slope (%)	=	2.20		0.00		0.00		
Surface description	=	Unpaved		Paved		Paved		
Average velocity (ft/s)	=	2.39		0.00		0.00		
Travel Time (min)	**=**	**4.04**	**+**	**0.00**	**+**	**0.00**	**=**	**4.04**
Channel Flow								
X sectional flow area (sqft)	=	0.00		0.00		0.00		
Wetted perimeter (ft)	=	0.00		0.00		0.00		
Channel slope (%)	=	0.00		0.00		0.00		
Manning's n-value	=	0.015		0.015		0.015		
Velocity (ft/s)	=	0.00		0.00		0.00		
Flow length (ft)	=	0.0		0.0		0.0		
Travel Time (min)	**=**	**0.00**	**+**	**0.00**	**+**	**0.00**	**=**	**0.00**

Total Travel Time, Tc ..... 30.60 min

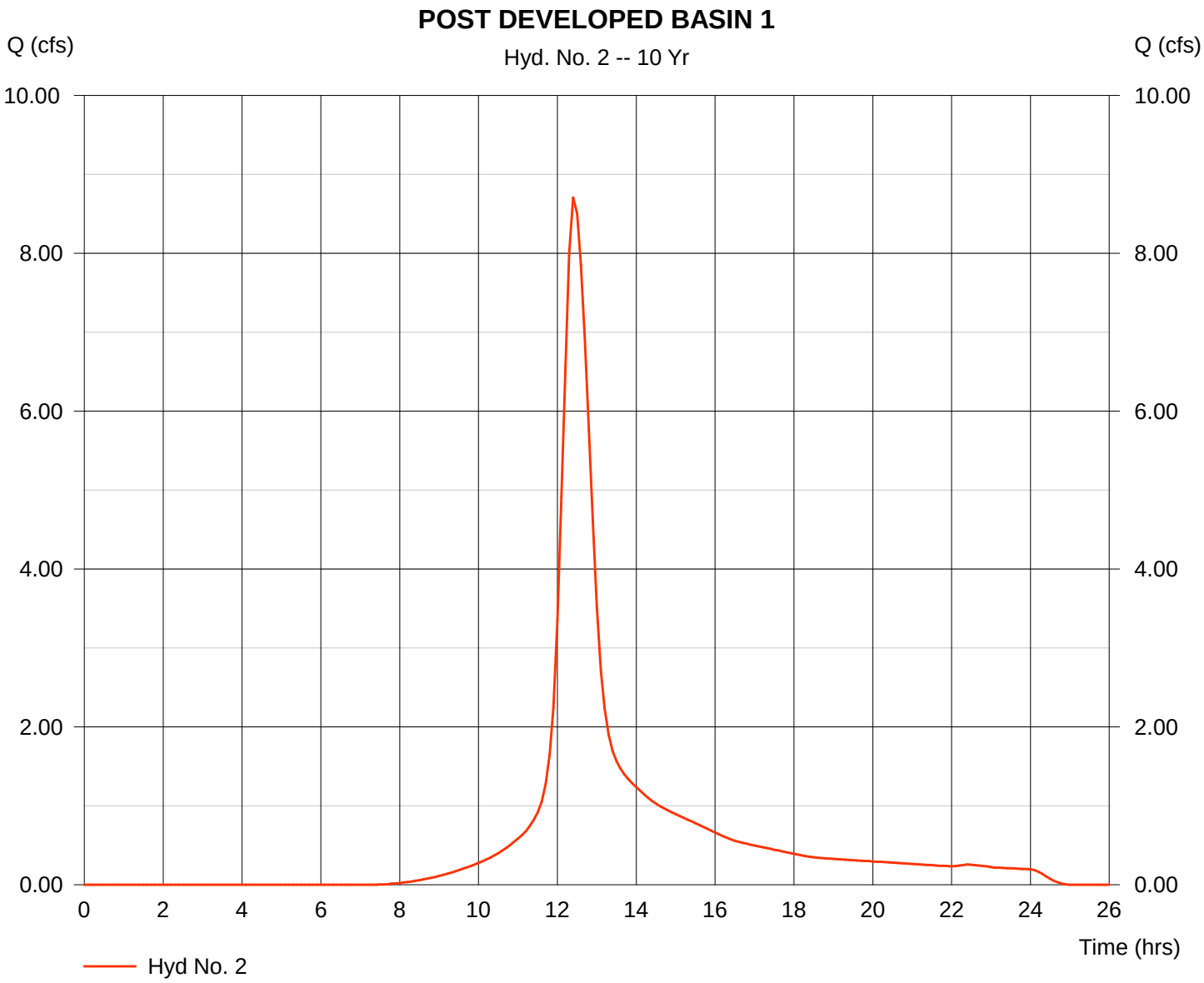
Hydrograph Plot

Hyd. No. 2

POST DEVELOPED BASIN 1

Hydrograph type	= SCS Runoff	Peak discharge	= 8.71 cfs
Storm frequency	= 10 yrs	Time interval	= 6 min
Drainage area	= 3.960 ac	Curve number	= 78
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 30.60 min
Total precip.	= 6.00 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

Hydrograph Volume = 53,054 cuft



TR55 Tc Worksheet

Hyd. No. 2

POST DEVELOPED BASIN 1

Description	A	B	C	Totals
Sheet Flow				
Manning's n-value	= 0.150	0.011	0.011	
Flow length (ft)	= 300.0	0.0	0.0	
Two-year 24-hr precip. (in)	= 4.07	0.00	0.00	
Land slope (%)	= 1.10	0.00	0.00	
Travel Time (min)	**= 26.57 +**	**0.00 +**	**0.00 =**	**26.57**
Shallow Concentrated Flow				
Flow length (ft)	= 580.00	0.00	0.00	
Watercourse slope (%)	= 2.20	0.00	0.00	
Surface description	= Unpaved	Paved	Paved	
Average velocity (ft/s)	= 2.39	0.00	0.00	
Travel Time (min)	**= 4.04 +**	**0.00 +**	**0.00 =**	**4.04**
Channel Flow				
X sectional flow area (sqft)	= 0.00	0.00	0.00	
Wetted perimeter (ft)	= 0.00	0.00	0.00	
Channel slope (%)	= 0.00	0.00	0.00	
Manning's n-value	= 0.015	0.015	0.015	
Velocity (ft/s)	= 0.00	0.00	0.00	
Flow length (ft)	= 0.0	0.0	0.0	
Travel Time (min)	**= 0.00 +**	**0.00 +**	**0.00 =**	**0.00**

Total Travel Time, Tc ..... 30.60 min

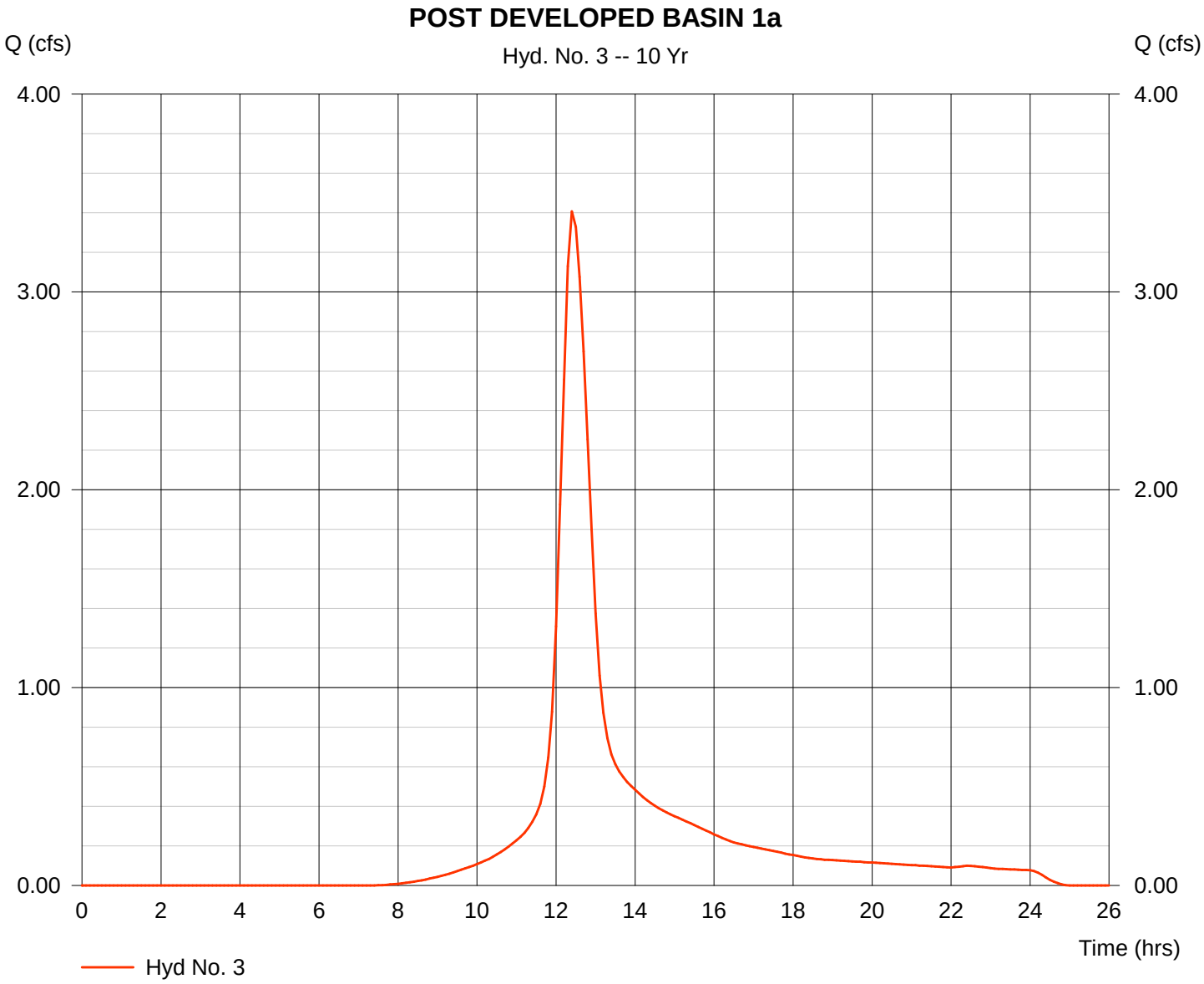
Hydrograph Plot

Hyd. No. 3

POST DEVELOPED BASIN 1a

Hydrograph type	= SCS Runoff	Peak discharge	= 3.41 cfs
Storm frequency	= 10 yrs	Time interval	= 6 min
Drainage area	= 1.550 ac	Curve number	= 78
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 30.60 min
Total precip.	= 6.00 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

Hydrograph Volume = 20,766 cuft



TR55 Tc Worksheet

Hyd. No. 3

POST DEVELOPED BASIN 1a

Description		A		B		C		Totals
Sheet Flow								
Manning's n-value	=	0.150		0.011		0.011		
Flow length (ft)	=	300.0		0.0		0.0		
Two-year 24-hr precip. (in)	=	4.07		0.00		0.00		
Land slope (%)	=	1.10		0.00		0.00		
Travel Time (min)	**=**	**26.57**	**+**	**0.00**	**+**	**0.00**	**=**	**26.57**
Shallow Concentrated Flow								
Flow length (ft)	=	580.00		0.00		0.00		
Watercourse slope (%)	=	2.20		0.00		0.00		
Surface description	=	Unpaved		Paved		Paved		
Average velocity (ft/s)	=	2.39		0.00		0.00		
Travel Time (min)	**=**	**4.04**	**+**	**0.00**	**+**	**0.00**	**=**	**4.04**
Channel Flow								
X sectional flow area (sqft)	=	0.00		0.00		0.00		
Wetted perimeter (ft)	=	0.00		0.00		0.00		
Channel slope (%)	=	0.00		0.00		0.00		
Manning's n-value	=	0.015		0.015		0.015		
Velocity (ft/s)	=	0.00		0.00		0.00		
Flow length (ft)	=	0.0		0.0		0.0		
Travel Time (min)	**=**	**0.00**	**+**	**0.00**	**+**	**0.00**	**=**	**0.00**

Total Travel Time, Tc ..... 30.60 min

Hydrograph Plot

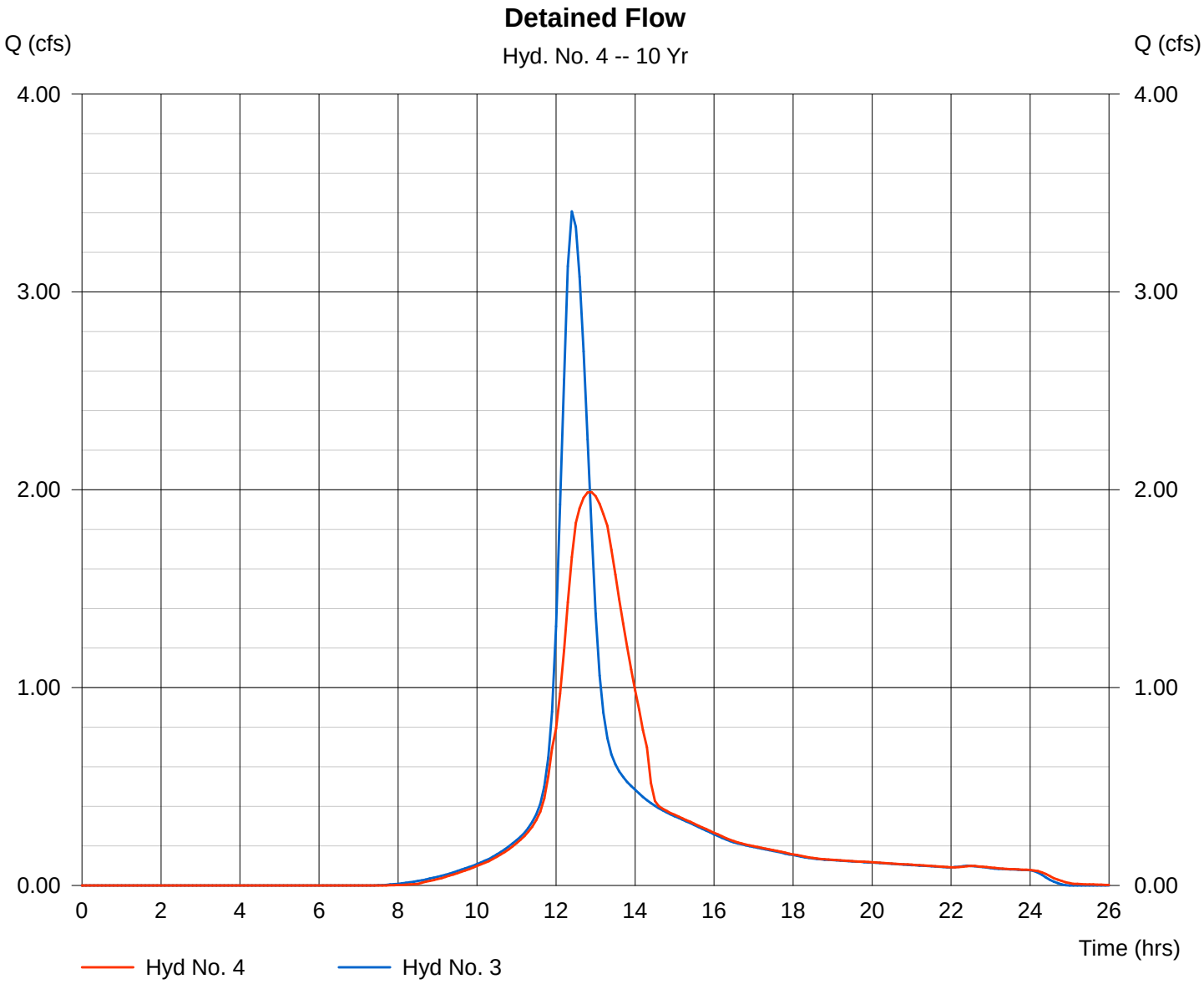
Hydraflow Hydrographs by Intelisolve | Monday, Jun 10 2013, 11:2 AM

Hyd. No. 4

Detained Flow

Hydrograph type	=	Reservoir	Peak discharge	=	1.99 cfs
Storm frequency	=	10 yrs	Time interval	=	6 min
Inflow hyd. No.	=	3	Max. Elevation	=	1347.23 ft
Reservoir name	=	Detention	Max. Storage	=	3,856 cuft

Storage Indication method used. | Hydrograph Volume = 20,763 cuft



Pond Report

Pond No. 1 - Detention

Pond Data

Pond storage is based on known contour areas. Average end area method used.

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	1345.50	10	0	0
0.50	1346.00	992	251	251
1.50	1347.00	3,959	2,476	2,726
2.50	1348.00	5,740	4,850	7,576

Culvert / Orifice Structures

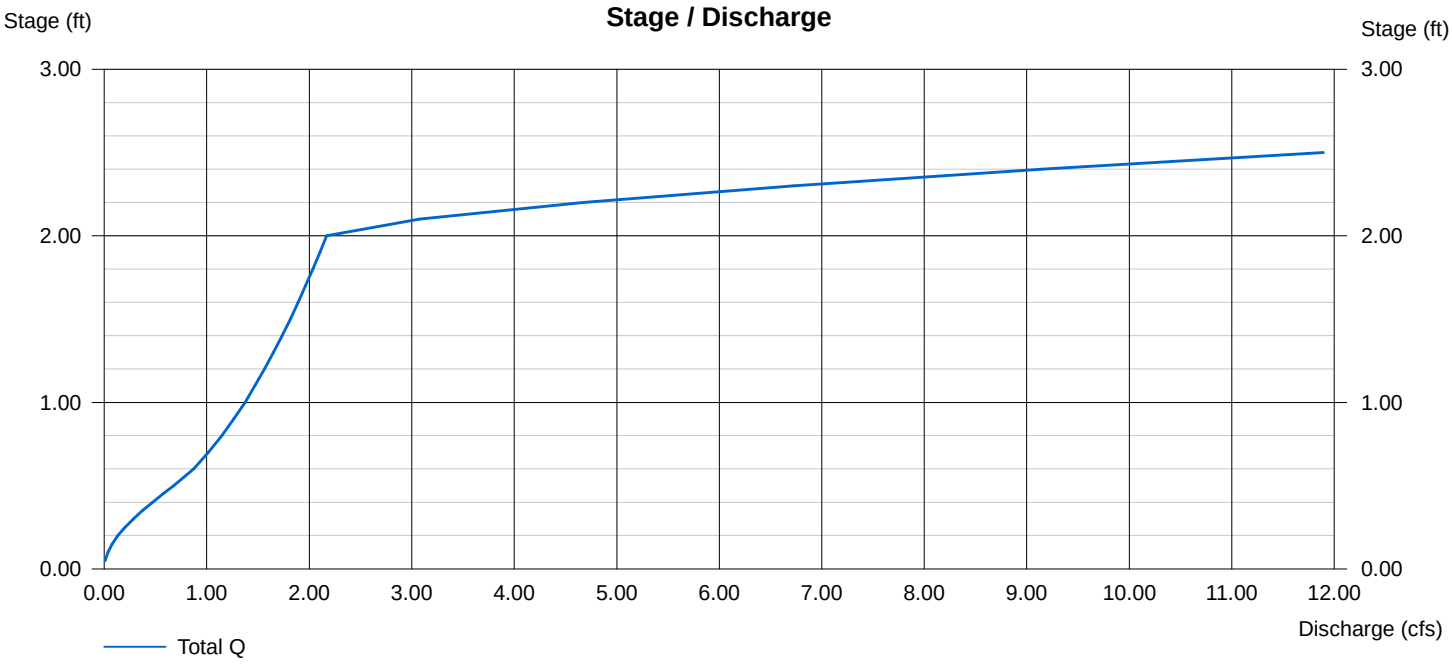
	[A]	[B]	[C]	[D]
Rise (in)	= 8.00	0.00	0.00	0.00
Span (in)	= 8.00	0.00	0.00	0.00
No. Barrels	= 1	0	0	0
Invert El. (ft)	= 1345.50	0.00	0.00	0.00
Length (ft)	= 20.00	0.00	0.00	0.00
Slope (%)	= 2.50	0.00	0.00	0.00
N-Value	= .013	.000	.000	.000
Orif. Coeff.	= 0.60	0.00	0.00	0.00
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 8.00	0.00	0.00	0.00
Crest El. (ft)	= 1347.50	0.00	0.00	0.00
Weir Coeff.	= 3.33	0.00	0.00	0.00
Weir Type	= Ciplti	---	---	---
Multi-Stage	= No	No	No	No

Exfiltration = 0.000 in/hr (Contour) Tailwater Elev. = 0.00 ft

Note: Culvert/Orifice outflows have been analyzed under inlet and outlet control.



Hydrograph Plot

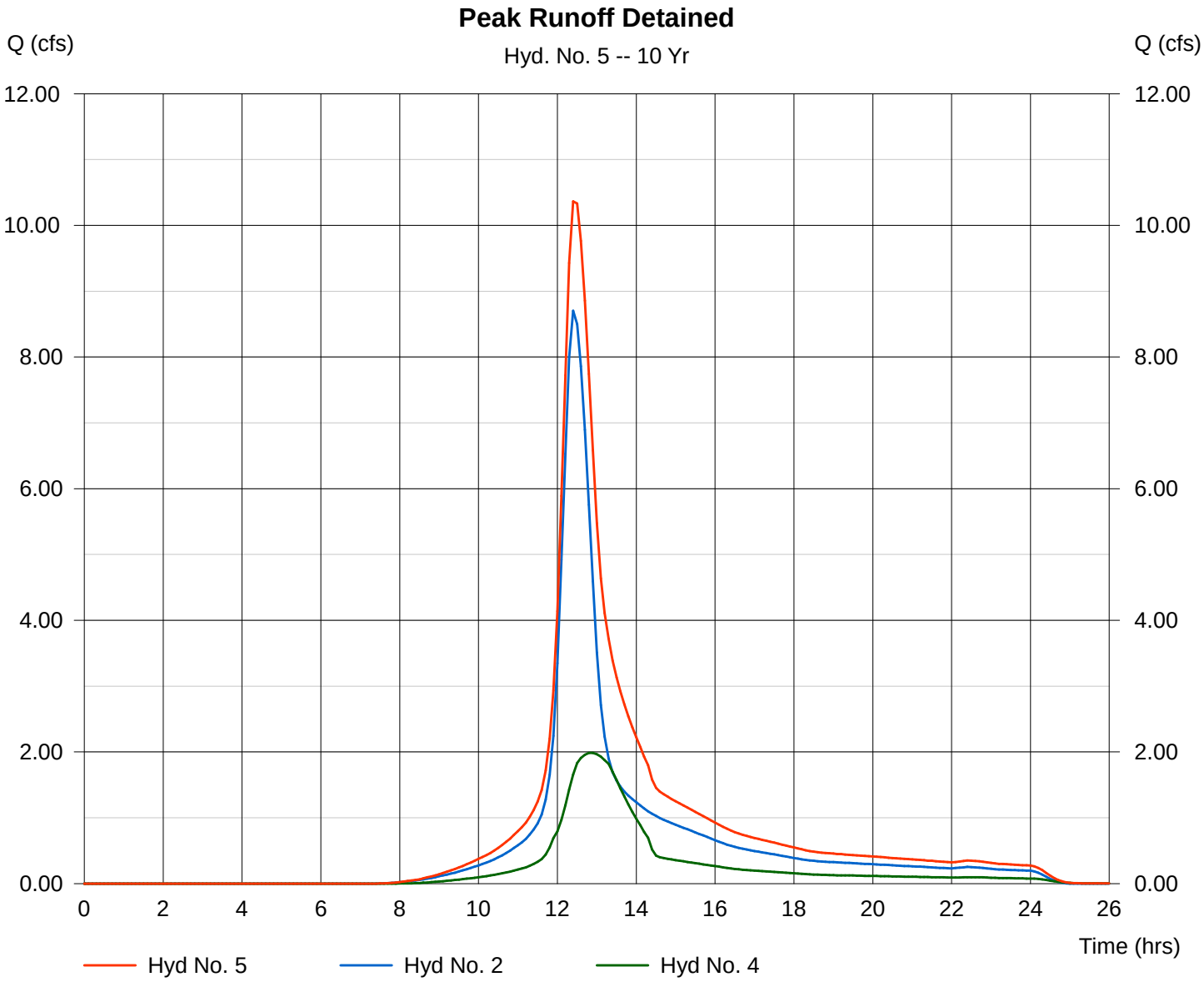
Hydraflow Hydrographs by Intelisolve | Monday, Jun 10 2013, 11:2 AM

Hyd. No. 5

Peak Runoff Detained

Hydrograph type	= Combine	Peak discharge	= 10.36 cfs
Storm frequency	= 10 yrs	Time interval	= 6 min
Inflow hyds.	= 2, 4		

Hydrograph Volume = 73,817 cuft



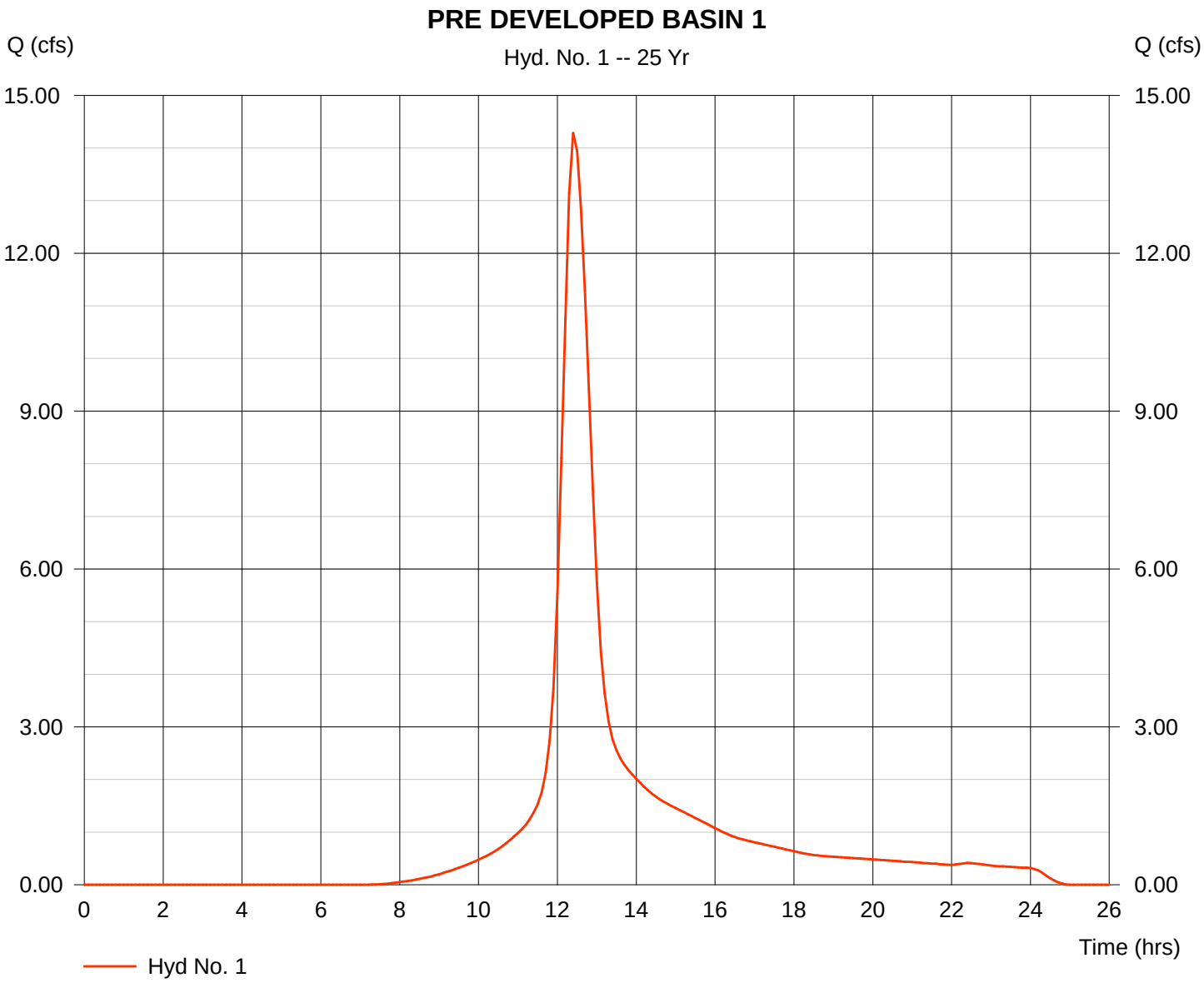
Hydrograph Plot

Hyd. No. 1

PRE DEVELOPED BASIN 1

Hydrograph type	= SCS Runoff	Peak discharge	= 14.29 cfs
Storm frequency	= 25 yrs	Time interval	= 6 min
Drainage area	= 5.510 ac	Curve number	= 76
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 30.60 min
Total precip.	= 6.96 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

Hydrograph Volume = 87,079 cuft



TR55 Tc Worksheet

Hyd. No. 1

PRE DEVELOPED BASIN 1

Description		A		B		C		Totals
Sheet Flow								
Manning's n-value	=	0.150		0.011		0.011		
Flow length (ft)	=	300.0		0.0		0.0		
Two-year 24-hr precip. (in)	=	4.07		0.00		0.00		
Land slope (%)	=	1.10		0.00		0.00		
Travel Time (min)	**=**	**26.57**	**+**	**0.00**	**+**	**0.00**	**=**	**26.57**
Shallow Concentrated Flow								
Flow length (ft)	=	580.00		0.00		0.00		
Watercourse slope (%)	=	2.20		0.00		0.00		
Surface description	=	Unpaved		Paved		Paved		
Average velocity (ft/s)	=	2.39		0.00		0.00		
Travel Time (min)	**=**	**4.04**	**+**	**0.00**	**+**	**0.00**	**=**	**4.04**
Channel Flow								
X sectional flow area (sqft)	=	0.00		0.00		0.00		
Wetted perimeter (ft)	=	0.00		0.00		0.00		
Channel slope (%)	=	0.00		0.00		0.00		
Manning's n-value	=	0.015		0.015		0.015		
Velocity (ft/s)	=	0.00		0.00		0.00		
Flow length (ft)	=	0.0		0.0		0.0		
Travel Time (min)	**=**	**0.00**	**+**	**0.00**	**+**	**0.00**	**=**	**0.00**

Total Travel Time, Tc ..... 30.60 min

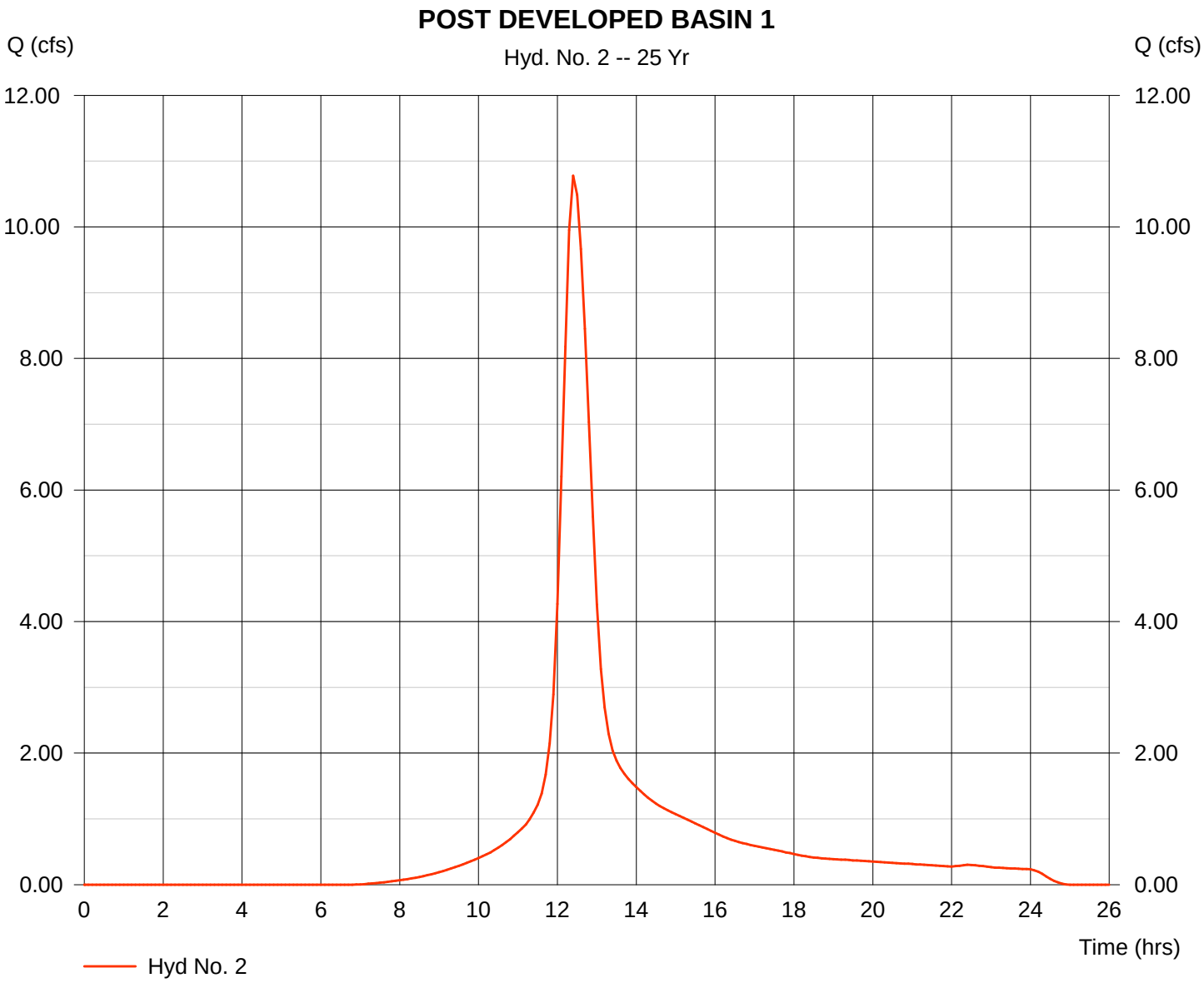
Hydrograph Plot

Hyd. No. 2

POST DEVELOPED BASIN 1

Hydrograph type	= SCS Runoff	Peak discharge	= 10.78 cfs
Storm frequency	= 25 yrs	Time interval	= 6 min
Drainage area	= 3.960 ac	Curve number	= 78
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 30.60 min
Total precip.	= 6.96 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

Hydrograph Volume = 65,797 cuft



TR55 Tc Worksheet

Hyd. No. 2

POST DEVELOPED BASIN 1

Description		A		B		C		Totals
Sheet Flow								
Manning's n-value	=	0.150		0.011		0.011		
Flow length (ft)	=	300.0		0.0		0.0		
Two-year 24-hr precip. (in)	=	4.07		0.00		0.00		
Land slope (%)	=	1.10		0.00		0.00		
Travel Time (min)	**=**	**26.57**	**+**	**0.00**	**+**	**0.00**	**=**	**26.57**
Shallow Concentrated Flow								
Flow length (ft)	=	580.00		0.00		0.00		
Watercourse slope (%)	=	2.20		0.00		0.00		
Surface description	=	Unpaved		Paved		Paved		
Average velocity (ft/s)	=	2.39		0.00		0.00		
Travel Time (min)	**=**	**4.04**	**+**	**0.00**	**+**	**0.00**	**=**	**4.04**
Channel Flow								
X sectional flow area (sqft)	=	0.00		0.00		0.00		
Wetted perimeter (ft)	=	0.00		0.00		0.00		
Channel slope (%)	=	0.00		0.00		0.00		
Manning's n-value	=	0.015		0.015		0.015		
Velocity (ft/s)	=	0.00		0.00		0.00		
Flow length (ft)	=	0.0		0.0		0.0		
Travel Time (min)	**=**	**0.00**	**+**	**0.00**	**+**	**0.00**	**=**	**0.00**

Total Travel Time, Tc ..... 30.60 min

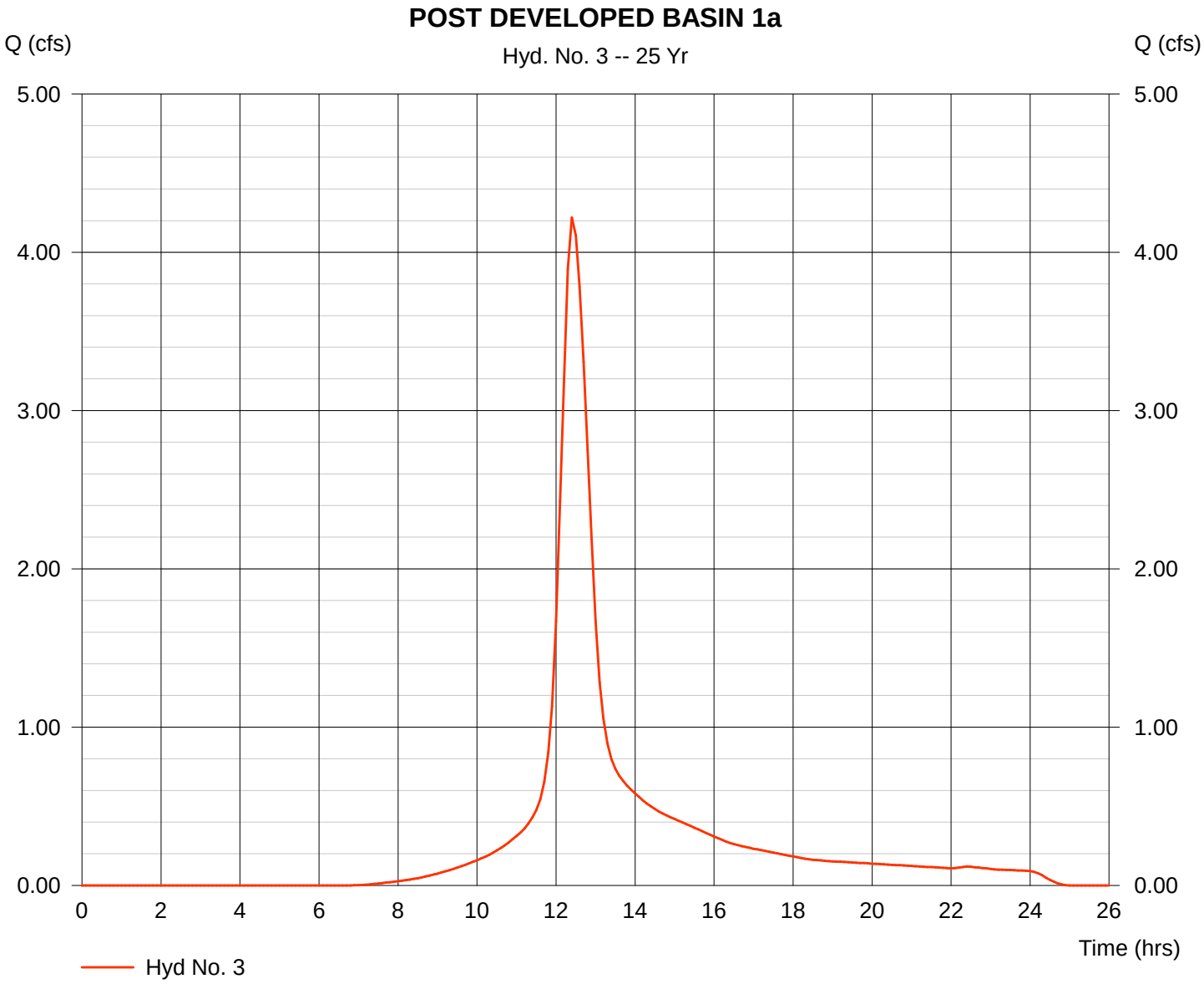
Hydrograph Plot

Hyd. No. 3

POST DEVELOPED BASIN 1a

Hydrograph type	= SCS Runoff	Peak discharge	= 4.22 cfs
Storm frequency	= 25 yrs	Time interval	= 6 min
Drainage area	= 1.550 ac	Curve number	= 78
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 30.60 min
Total precip.	= 6.96 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

Hydrograph Volume = 25,754 cuft



TR55 Tc Worksheet

Hyd. No. 3

POST DEVELOPED BASIN 1a

Description		A		B		C		Totals
Sheet Flow								
Manning's n-value	=	0.150		0.011		0.011		
Flow length (ft)	=	300.0		0.0		0.0		
Two-year 24-hr precip. (in)	=	4.07		0.00		0.00		
Land slope (%)	=	1.10		0.00		0.00		
Travel Time (min)	**=**	**26.57**	**+**	**0.00**	**+**	**0.00**	**=**	**26.57**
Shallow Concentrated Flow								
Flow length (ft)	=	580.00		0.00		0.00		
Watercourse slope (%)	=	2.20		0.00		0.00		
Surface description	=	Unpaved		Paved		Paved		
Average velocity (ft/s)	=	2.39		0.00		0.00		
Travel Time (min)	**=**	**4.04**	**+**	**0.00**	**+**	**0.00**	**=**	**4.04**
Channel Flow								
X sectional flow area (sqft)	=	0.00		0.00		0.00		
Wetted perimeter (ft)	=	0.00		0.00		0.00		
Channel slope (%)	=	0.00		0.00		0.00		
Manning's n-value	=	0.015		0.015		0.015		
Velocity (ft/s)	=	0.00		0.00		0.00		
Flow length (ft)	=	0.0		0.0		0.0		
Travel Time (min)	**=**	**0.00**	**+**	**0.00**	**+**	**0.00**	**=**	**0.00**

Total Travel Time, Tc ..... 30.60 min

Hydrograph Plot

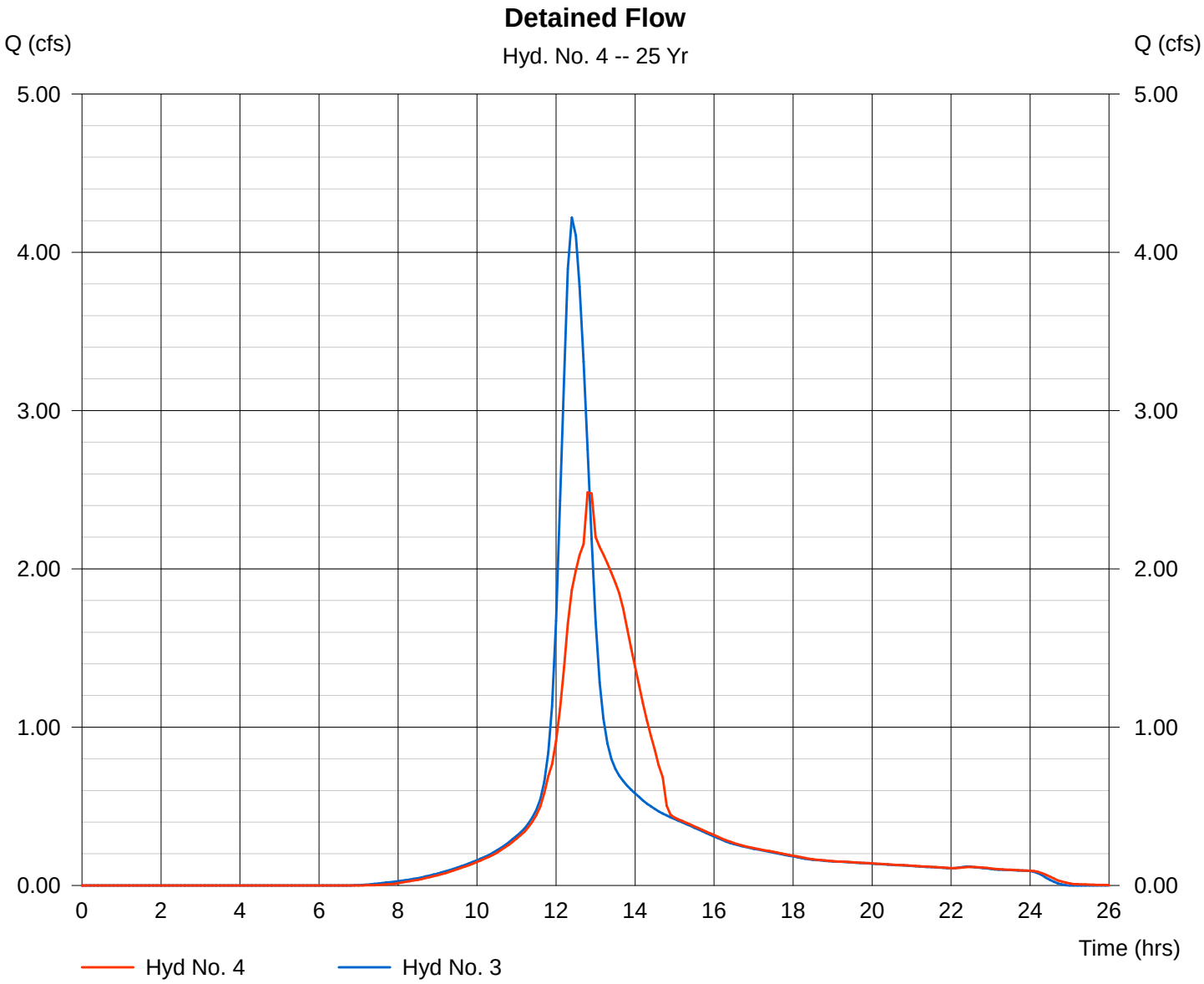
Hyd. No. 4

Detained Flow

Hydrograph type	=	Reservoir	Peak discharge	=	2.48 cfs
Storm frequency	=	25 yrs	Time interval	=	6 min
Inflow hyd. No.	=	3	Max. Elevation	=	1347.54 ft
Reservoir name	=	Detention	Max. Storage	=	5,319 cuft

Storage Indication method used.

Hydrograph Volume = 25,751 cuft



Pond Report

Pond No. 1 - Detention

Pond Data

Pond storage is based on known contour areas. Average end area method used.

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	1345.50	10	0	0
0.50	1346.00	992	251	251
1.50	1347.00	3,959	2,476	2,726
2.50	1348.00	5,740	4,850	7,576

Culvert / Orifice Structures

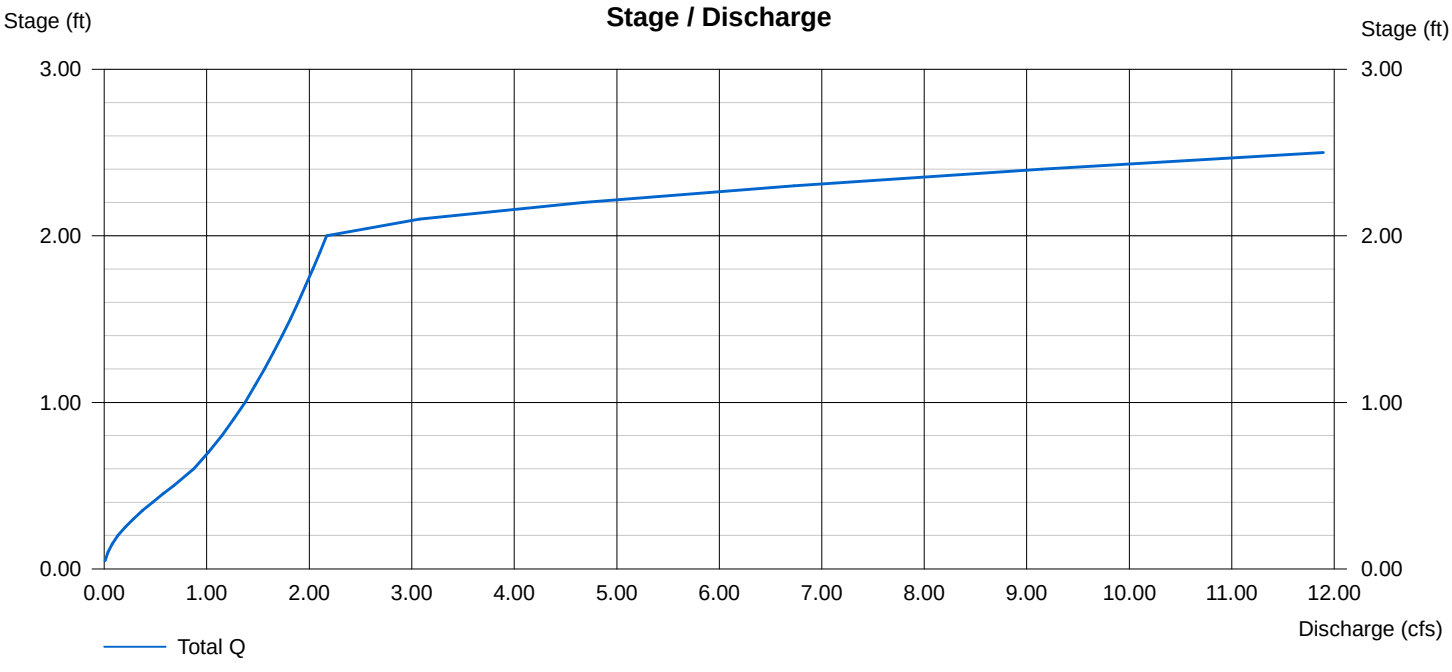
	[A]	[B]	[C]	[D]
Rise (in)	= 8.00	0.00	0.00	0.00
Span (in)	= 8.00	0.00	0.00	0.00
No. Barrels	= 1	0	0	0
Invert El. (ft)	= 1345.50	0.00	0.00	0.00
Length (ft)	= 20.00	0.00	0.00	0.00
Slope (%)	= 2.50	0.00	0.00	0.00
N-Value	= .013	.000	.000	.000
Orif. Coeff.	= 0.60	0.00	0.00	0.00
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 8.00	0.00	0.00	0.00
Crest El. (ft)	= 1347.50	0.00	0.00	0.00
Weir Coeff.	= 3.33	0.00	0.00	0.00
Weir Type	= Ciplti	---	---	---
Multi-Stage	= No	No	No	No

Exfiltration = 0.000 in/hr (Contour) Tailwater Elev. = 0.00 ft

Note: Culvert/Orifice outflows have been analyzed under inlet and outlet control.



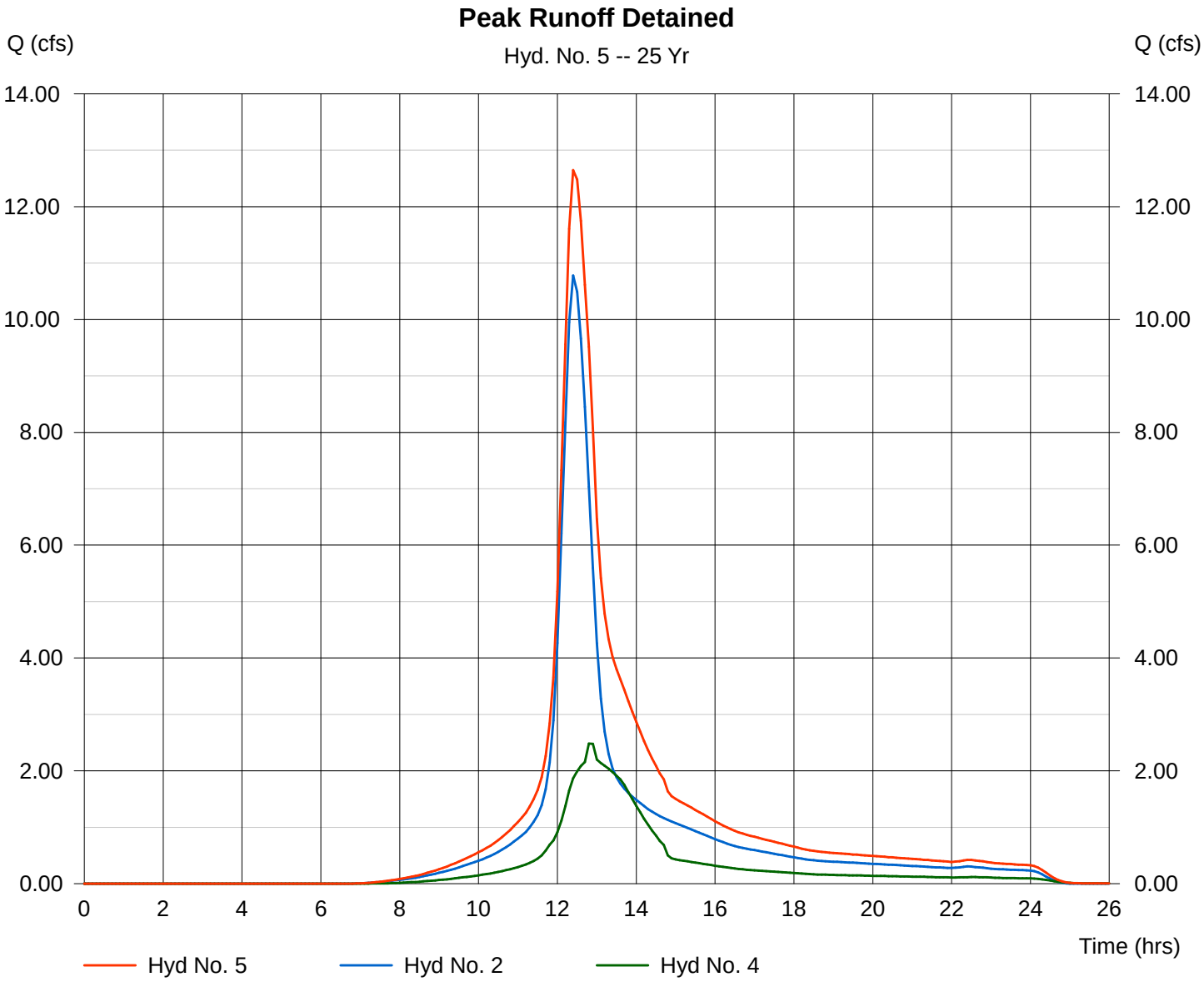
Hydrograph Plot

Hyd. No. 5

Peak Runoff Detained

Hydrograph type	= Combine	Peak discharge	= 12.65 cfs
Storm frequency	= 25 yrs	Time interval	= 6 min
Inflow hyds.	= 2, 4		

Hydrograph Volume = 91,548 cuft



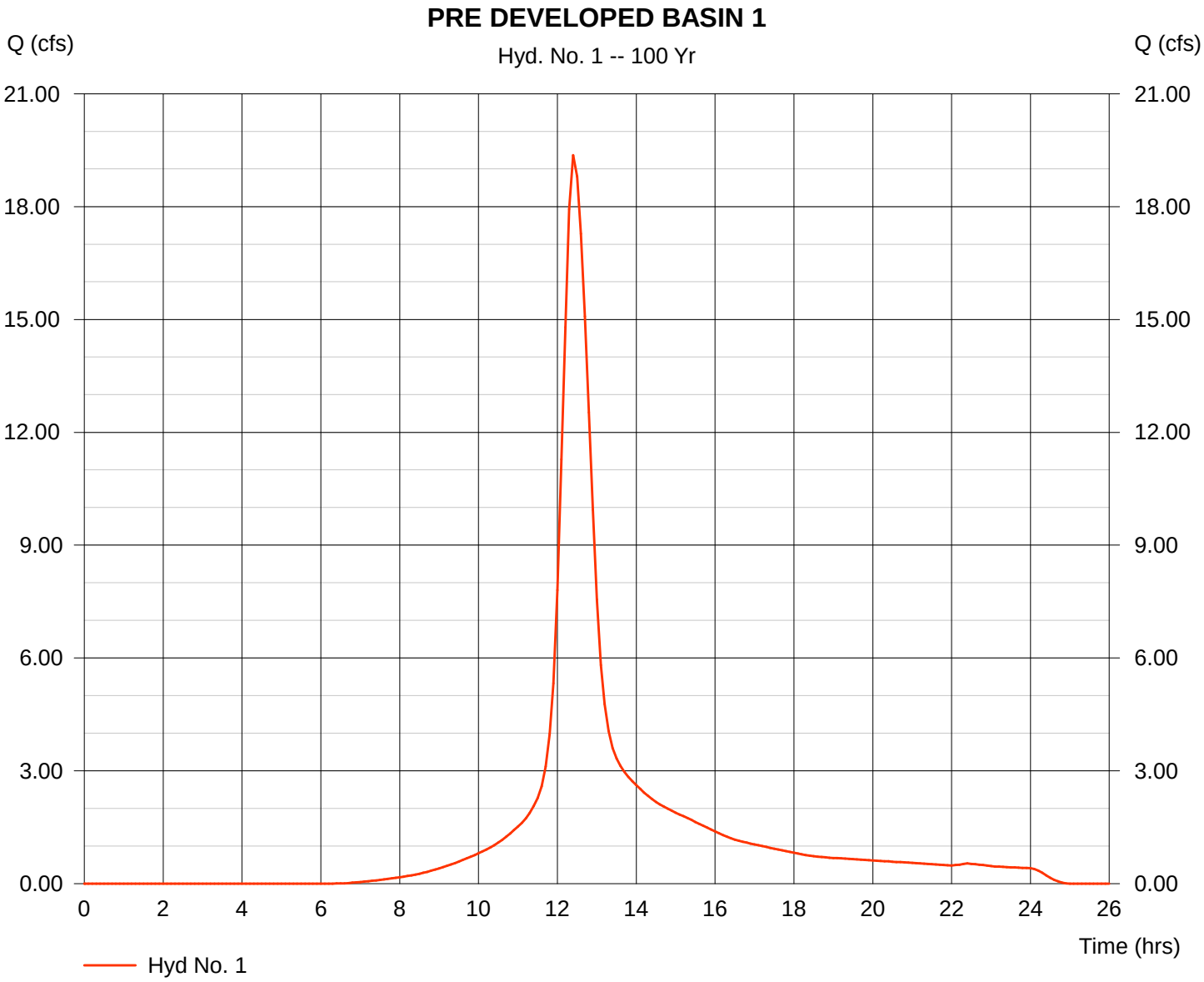
Hydrograph Plot

Hyd. No. 1

PRE DEVELOPED BASIN 1

Hydrograph type	= SCS Runoff	Peak discharge	= 19.37 cfs
Storm frequency	= 100 yrs	Time interval	= 6 min
Drainage area	= 5.510 ac	Curve number	= 76
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 30.60 min
Total precip.	= 8.64 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

Hydrograph Volume = 118,469 cuft



TR55 Tc Worksheet

Hyd. No. 1

PRE DEVELOPED BASIN 1

Description		A		B		C		Totals
Sheet Flow								
Manning's n-value	=	0.150		0.011		0.011		
Flow length (ft)	=	300.0		0.0		0.0		
Two-year 24-hr precip. (in)	=	4.07		0.00		0.00		
Land slope (%)	=	1.10		0.00		0.00		
Travel Time (min)	**=**	**26.57**	**+**	**0.00**	**+**	**0.00**	**=**	**26.57**
Shallow Concentrated Flow								
Flow length (ft)	=	580.00		0.00		0.00		
Watercourse slope (%)	=	2.20		0.00		0.00		
Surface description	=	Unpaved		Paved		Paved		
Average velocity (ft/s)	=	2.39		0.00		0.00		
Travel Time (min)	**=**	**4.04**	**+**	**0.00**	**+**	**0.00**	**=**	**4.04**
Channel Flow								
X sectional flow area (sqft)	=	0.00		0.00		0.00		
Wetted perimeter (ft)	=	0.00		0.00		0.00		
Channel slope (%)	=	0.00		0.00		0.00		
Manning's n-value	=	0.015		0.015		0.015		
Velocity (ft/s)	=	0.00		0.00		0.00		
Flow length (ft)	=	0.0		0.0		0.0		
Travel Time (min)	**=**	**0.00**	**+**	**0.00**	**+**	**0.00**	**=**	**0.00**

Total Travel Time, Tc ..... 30.60 min

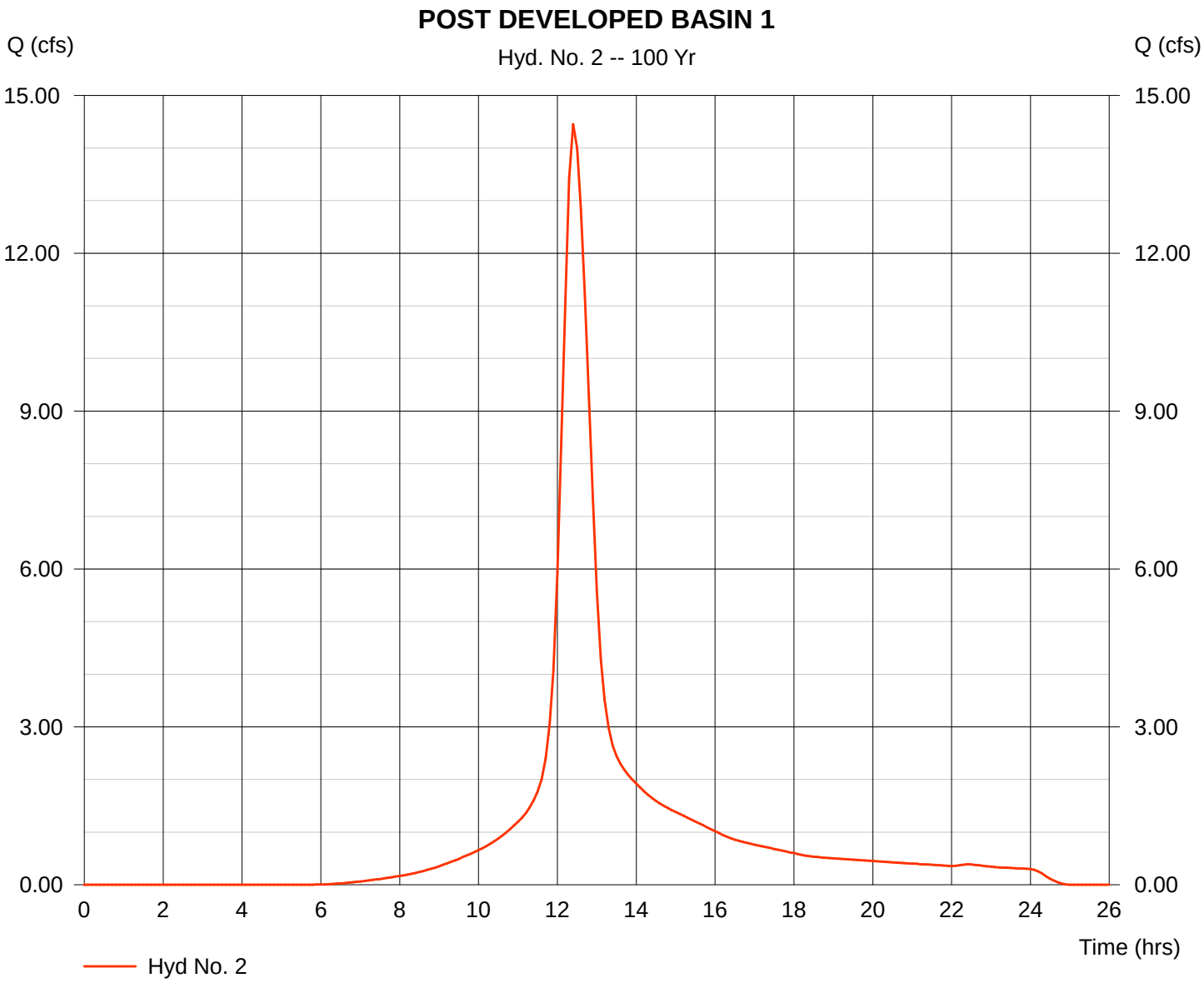
Hydrograph Plot

Hyd. No. 2

POST DEVELOPED BASIN 1

Hydrograph type	= SCS Runoff	Peak discharge	= 14.45 cfs
Storm frequency	= 100 yrs	Time interval	= 6 min
Drainage area	= 3.960 ac	Curve number	= 78
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 30.60 min
Total precip.	= 8.64 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

Hydrograph Volume = 88,729 cuft



TR55 Tc Worksheet

Hyd. No. 2

POST DEVELOPED BASIN 1

Description	A	B	C	Totals
Sheet Flow				
Manning's n-value	= 0.150	0.011	0.011	
Flow length (ft)	= 300.0	0.0	0.0	
Two-year 24-hr precip. (in)	= 4.07	0.00	0.00	
Land slope (%)	= 1.10	0.00	0.00	
Travel Time (min)	**= 26.57**	**+ 0.00**	**+ 0.00**	**= 26.57**
Shallow Concentrated Flow				
Flow length (ft)	= 580.00	0.00	0.00	
Watercourse slope (%)	= 2.20	0.00	0.00	
Surface description	= Unpaved	Paved	Paved	
Average velocity (ft/s)	= 2.39	0.00	0.00	
Travel Time (min)	**= 4.04**	**+ 0.00**	**+ 0.00**	**= 4.04**
Channel Flow				
X sectional flow area (sqft)	= 0.00	0.00	0.00	
Wetted perimeter (ft)	= 0.00	0.00	0.00	
Channel slope (%)	= 0.00	0.00	0.00	
Manning's n-value	= 0.015	0.015	0.015	
Velocity (ft/s)	= 0.00	0.00	0.00	
Flow length (ft)	= 0.0	0.0	0.0	
Travel Time (min)	**= 0.00**	**+ 0.00**	**+ 0.00**	**= 0.00**

Total Travel Time, Tc ..... 30.60 min

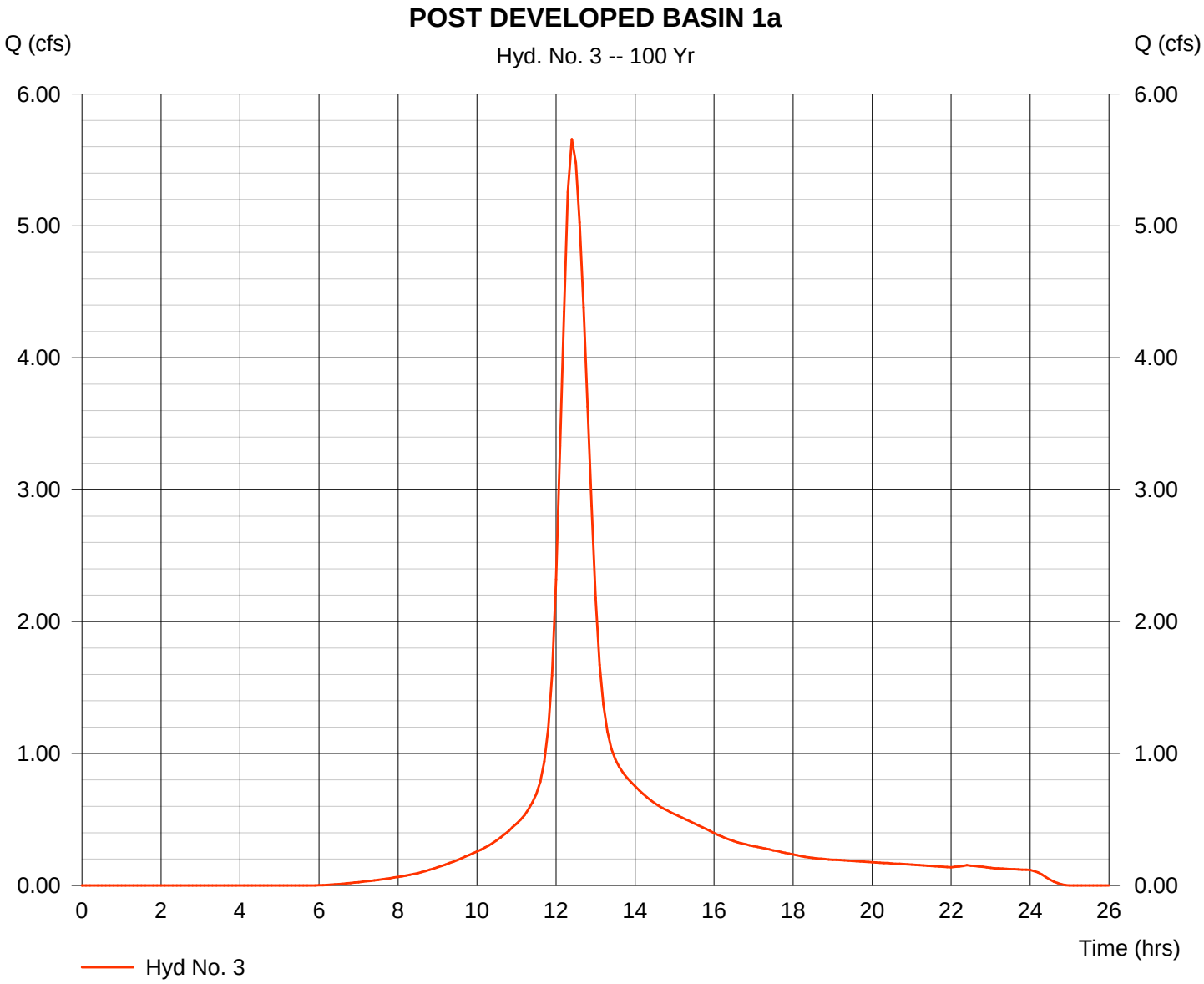
Hydrograph Plot

Hyd. No. 3

POST DEVELOPED BASIN 1a

Hydrograph type	= SCS Runoff	Peak discharge	= 5.66 cfs
Storm frequency	= 100 yrs	Time interval	= 6 min
Drainage area	= 1.550 ac	Curve number	= 78
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 30.60 min
Total precip.	= 8.64 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

Hydrograph Volume = 34,730 cuft



TR55 Tc Worksheet

Hyd. No. 3

POST DEVELOPED BASIN 1a

Description		A		B		C		Totals
Sheet Flow								
Manning's n-value	=	0.150		0.011		0.011		
Flow length (ft)	=	300.0		0.0		0.0		
Two-year 24-hr precip. (in)	=	4.07		0.00		0.00		
Land slope (%)	=	1.10		0.00		0.00		
Travel Time (min)	**=**	**26.57**	**+**	**0.00**	**+**	**0.00**	**=**	**26.57**
Shallow Concentrated Flow								
Flow length (ft)	=	580.00		0.00		0.00		
Watercourse slope (%)	=	2.20		0.00		0.00		
Surface description	=	Unpaved		Paved		Paved		
Average velocity (ft/s)	=	2.39		0.00		0.00		
Travel Time (min)	**=**	**4.04**	**+**	**0.00**	**+**	**0.00**	**=**	**4.04**
Channel Flow								
X sectional flow area (sqft)	=	0.00		0.00		0.00		
Wetted perimeter (ft)	=	0.00		0.00		0.00		
Channel slope (%)	=	0.00		0.00		0.00		
Manning's n-value	=	0.015		0.015		0.015		
Velocity (ft/s)	=	0.00		0.00		0.00		
Flow length (ft)	=	0.0		0.0		0.0		
Travel Time (min)	**=**	**0.00**	**+**	**0.00**	**+**	**0.00**	**=**	**0.00**

Total Travel Time, Tc ..... 30.60 min

Hydrograph Plot

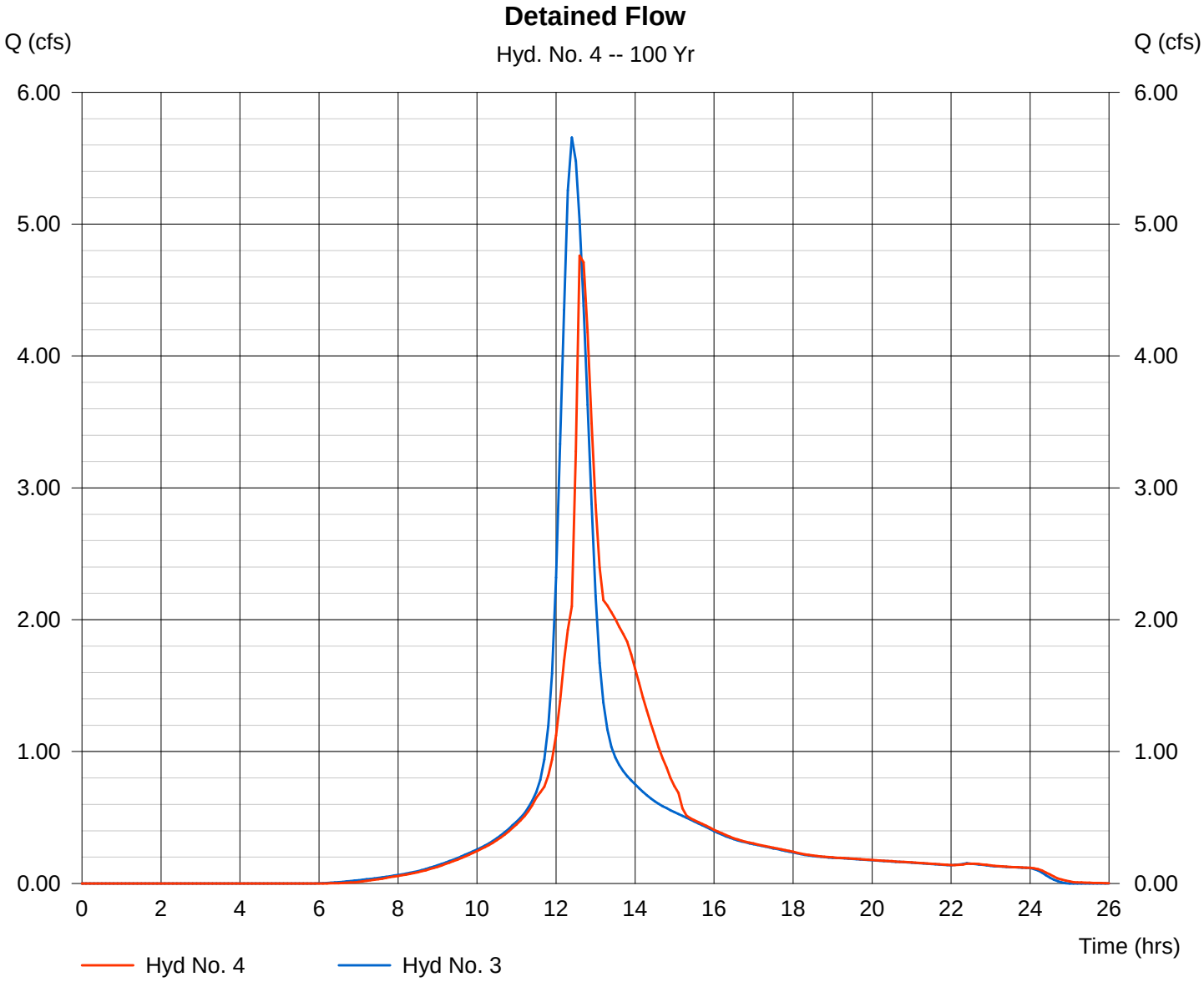
Hydraflow Hydrographs by Intelisolve | Monday, Jun 10 2013, 11:2 AM

Hyd. No. 4

Detained Flow

Hydrograph type	=	Reservoir	Peak discharge	=	4.76 cfs
Storm frequency	=	100 yrs	Time interval	=	6 min
Inflow hyd. No.	=	3	Max. Elevation	=	1347.70 ft
Reservoir name	=	Detention	Max. Storage	=	6,141 cuft

Storage Indication method used. | Hydrograph Volume = 34,727 cuft



Pond Report

Pond No. 1 - Detention

Pond Data

Pond storage is based on known contour areas. Average end area method used.

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	1345.50	10	0	0
0.50	1346.00	992	251	251
1.50	1347.00	3,959	2,476	2,726
2.50	1348.00	5,740	4,850	7,576

Culvert / Orifice Structures

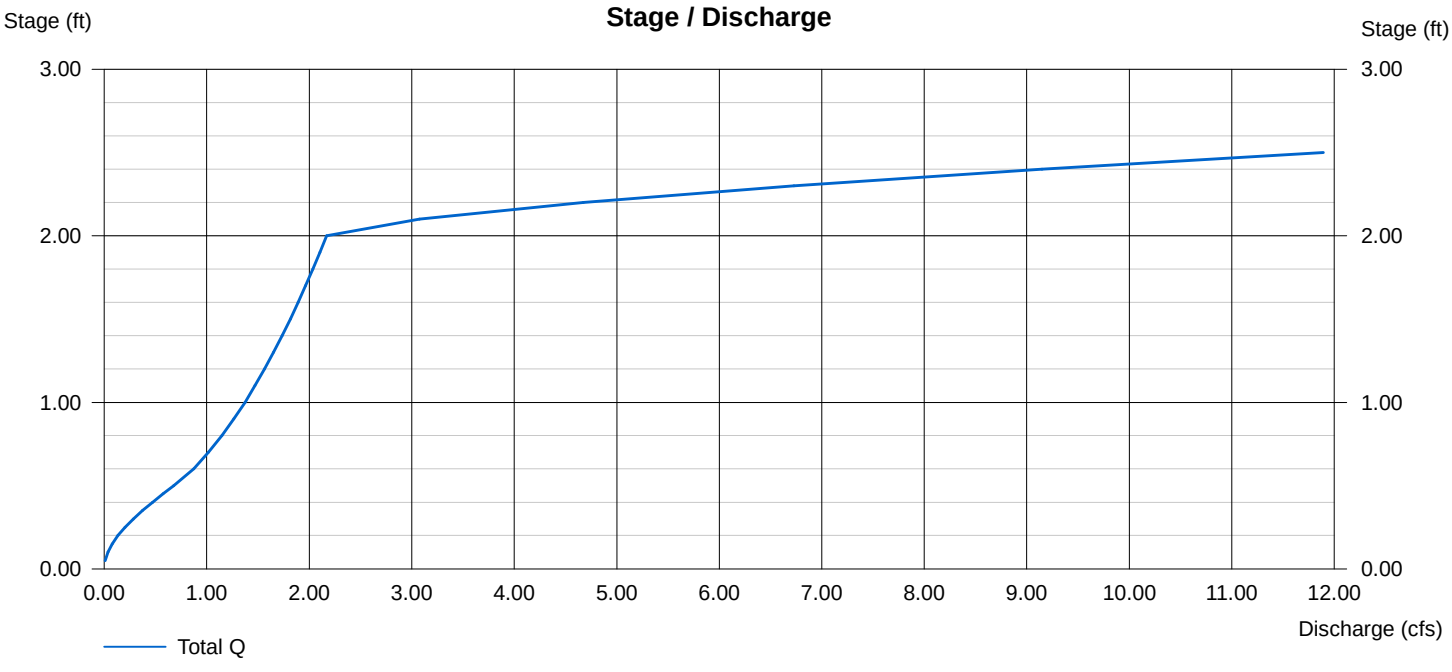
	[A]	[B]	[C]	[D]
Rise (in)	= 8.00	0.00	0.00	0.00
Span (in)	= 8.00	0.00	0.00	0.00
No. Barrels	= 1	0	0	0
Invert El. (ft)	= 1345.50	0.00	0.00	0.00
Length (ft)	= 20.00	0.00	0.00	0.00
Slope (%)	= 2.50	0.00	0.00	0.00
N-Value	= .013	.000	.000	.000
Orif. Coeff.	= 0.60	0.00	0.00	0.00
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 8.00	0.00	0.00	0.00
Crest El. (ft)	= 1347.50	0.00	0.00	0.00
Weir Coeff.	= 3.33	0.00	0.00	0.00
Weir Type	= Ciplti	---	---	---
Multi-Stage	= No	No	No	No

Exfiltration = 0.000 in/hr (Contour) Tailwater Elev. = 0.00 ft

Note: Culvert/Orifice outflows have been analyzed under inlet and outlet control.

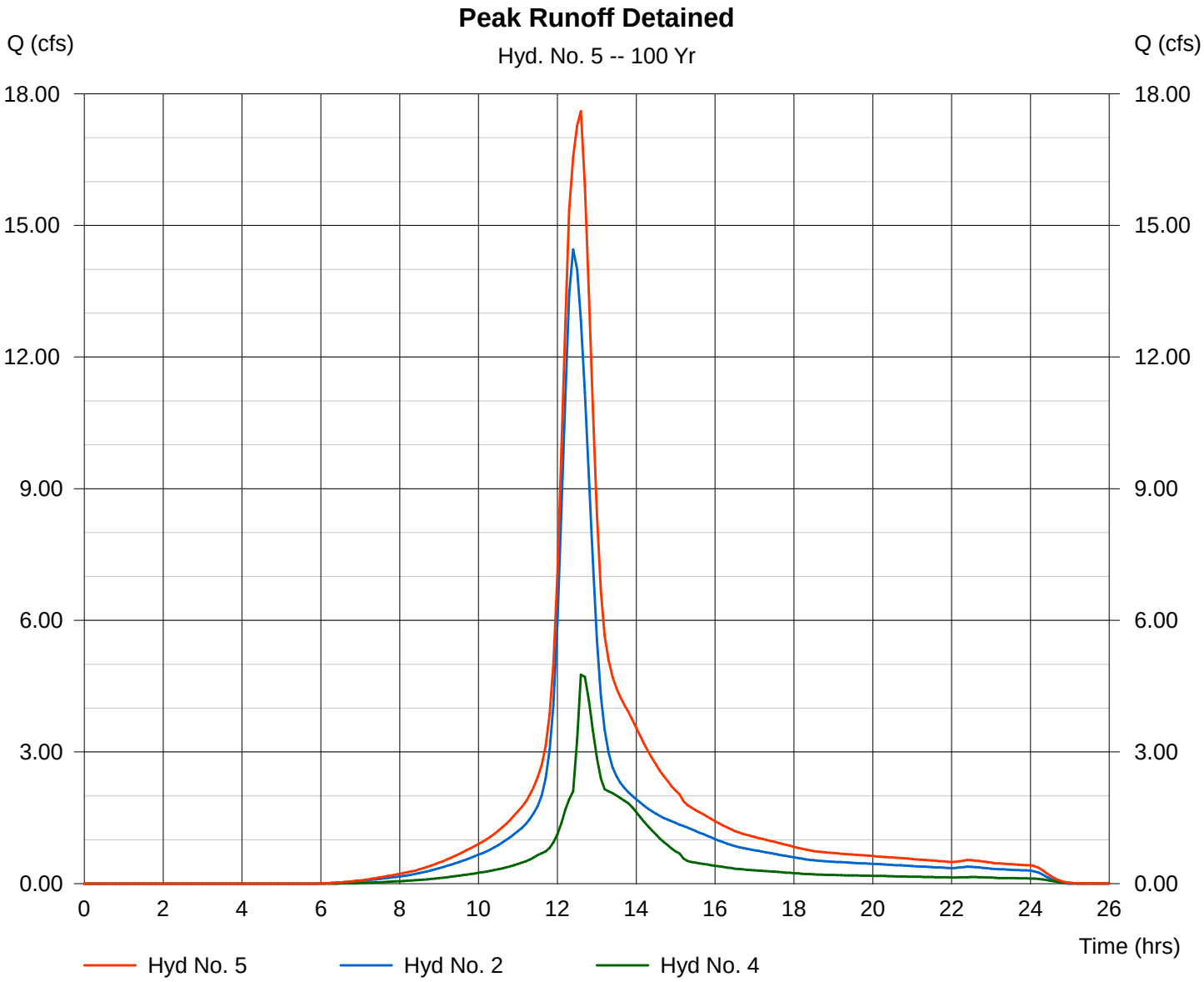


Hydrograph Plot

Hydraflow Hydrographs by Intelisolve | Monday, Jun 10 2013, 11:2 AM

Hyd. No. 5

Peak Runoff Detained

Hydrograph type	= Combine	Peak discharge	= 17.60 cfs
Storm frequency	= 100 yrs	Time interval	= 6 min
Inflow hyds.	= 2, 4		

Hydrograph Volume = 123,456 cuft